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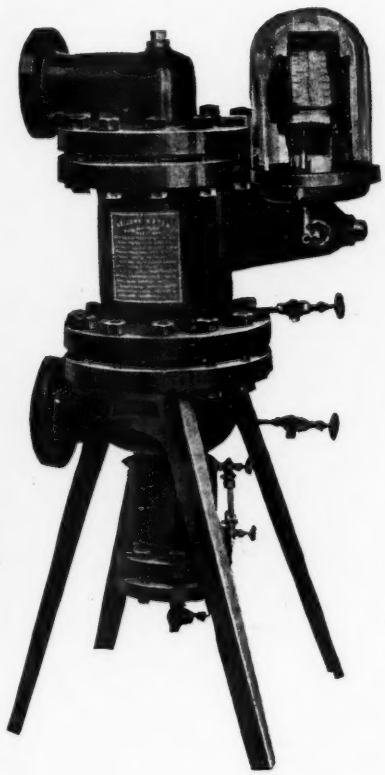
Vol. XVI APRIL, 1911 No. 4



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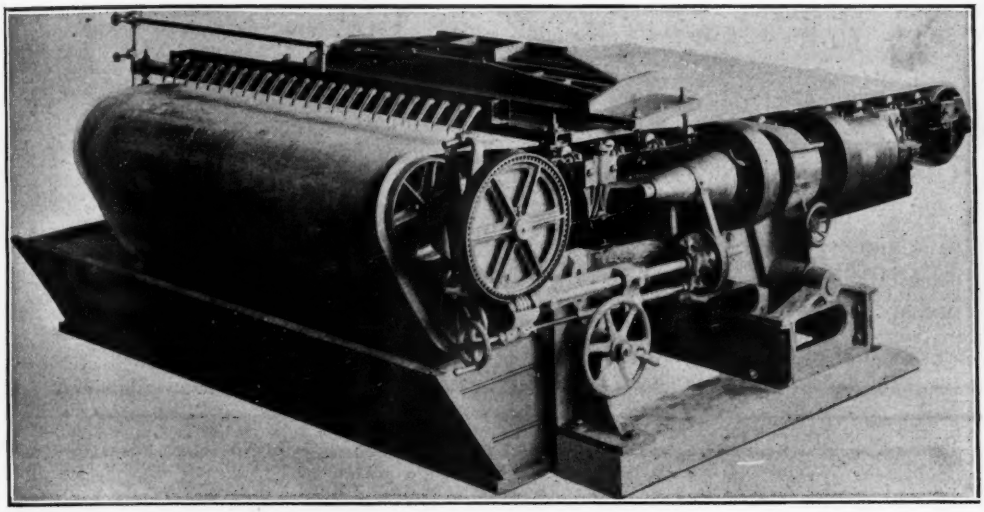

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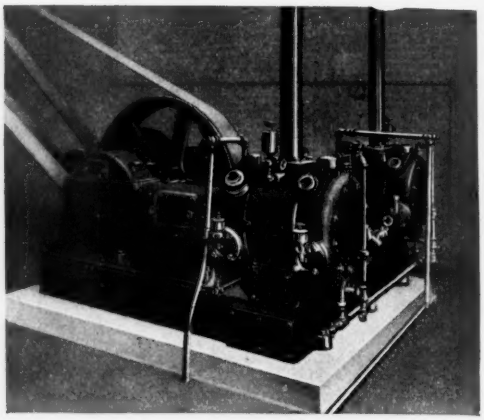

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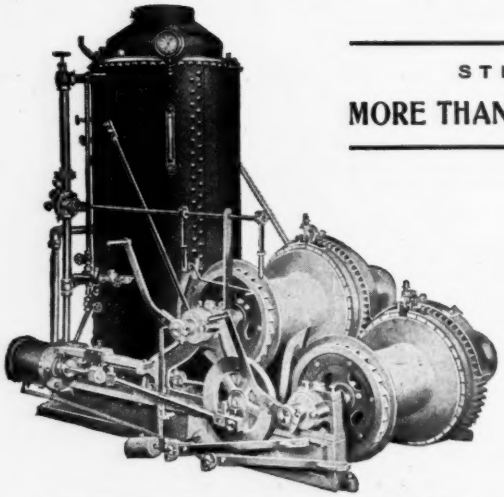

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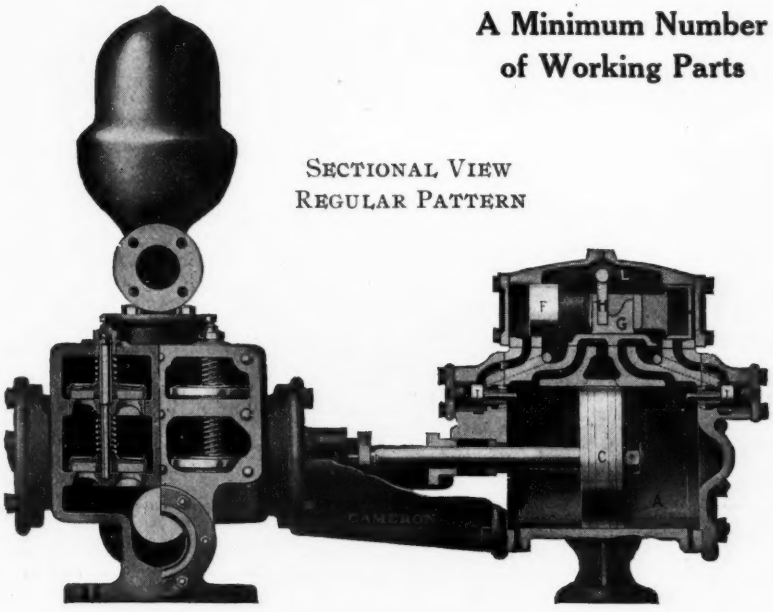

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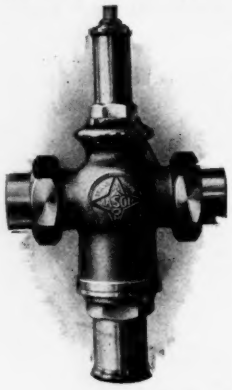

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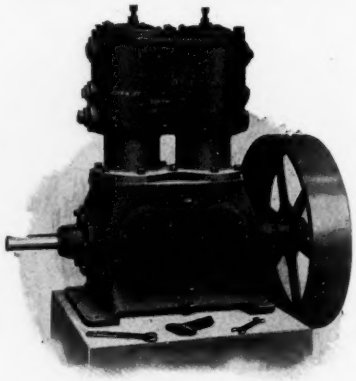

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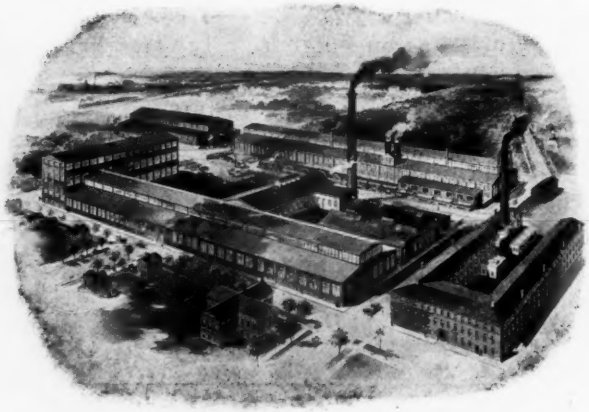

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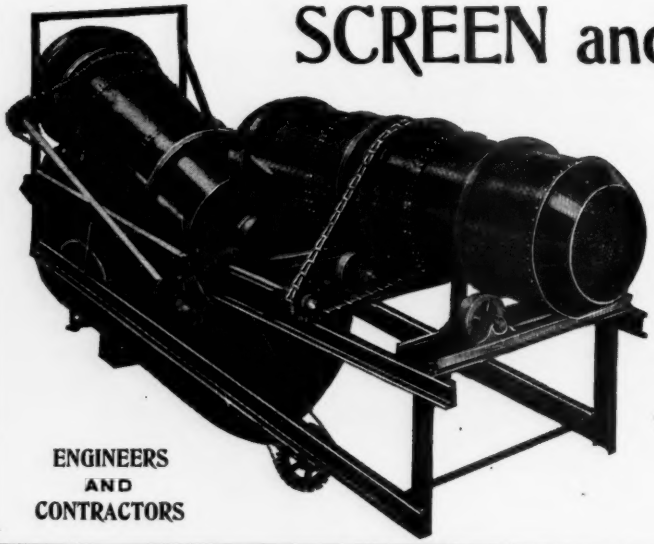

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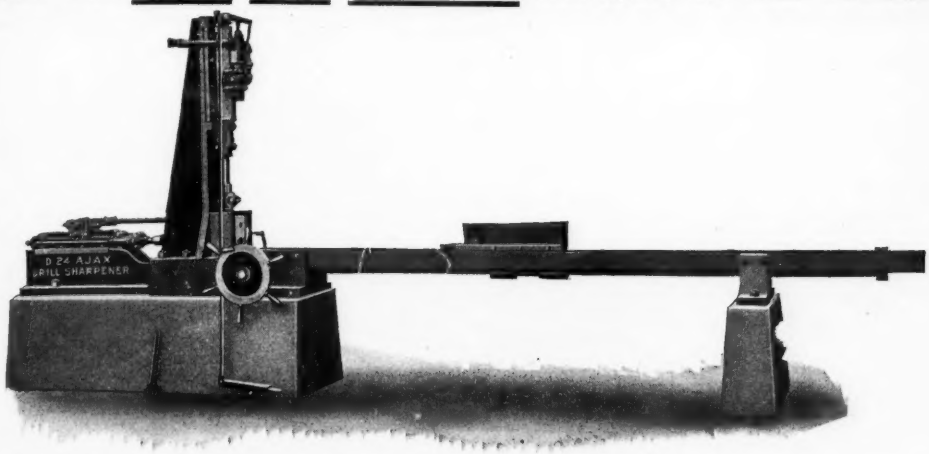

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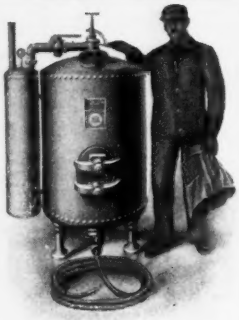

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EVERYTHING PNEUMATIC.

Vol. XVI APRIL, 1911 No. 4

SHALLOW AGAINST DEEP HOLES IN HEADINGS

By W. L. Saunders.

The most marked difference between the system of driving headings in rock in America as compared with the European, or what is generally known as the Alpine, system is that in America deep holes are driven while in Europe the holes are shallow. Holes 8, 10 and even 12 feet deep are not uncommon in tunnel headings in the United States, while in the Alps the usual depth of hole is only a little more than one-third of these figures.

It is now generally admitted by engineers of experience in this matter that tunnels are driven in the Alps at double the speed at which they are driven in the United States, hence it becomes a question of moment as to what influence shallow holes have upon the speed of tunnel driving. In considering this subject we at once ask, what size of rock drill is used? It would seem, of course, that in these shallow holes smaller drills must be used, but this is not the case. The rapid tunnel driving in the Alps, where shallow holes are put in, is done with drills about 3½ or 3⅝ inches in diameter, and, as in the case of the Loetschberg south heading, these drills are made in America, and are identical with those used here for the same class of work.

The next question is, what is the nature of the rock? and the answer to this is that it does not make any difference. The rock may be hard or soft, yet there appears to be in America a general tendency to use deep holes, while in Europe there is the opposite tendency.

The distinct difference, however, is in the mounting of the rock drill, which in the United States is a column or a shaft bar, while in Europe it is a small carriage, carrying a shaft bar or column, and in this we have the key to the situation. A column carrying a rock drill on an arm, which is the usual practice, must have the muck cleared away at its base and it must be jacked in place securely. The rock drill when mounted on this column has a limited range of working; only a limited number of holes can be drilled before this column must be moved to another place, hence the tendency is to put in those holes as deep as practicable, so as not to lose time in changing the mounting.

In the Alps a single bar carries all the drills and this bar when once put in place across the heading, by means of the carriage, is securely jacked, and, except where the conditions are exceptionally difficult, it serves until all the holes are drilled. This bar forms a rigid abutment resisting the blow of the drill. It is usually placed above the top of the muck and in some cases it is lowered afterwards for the bottom holes, but in no case does it require anything like the time or attention for adjustments that is usual with the column system. As it is an easy matter to move a rock drill from one hole to another on this horizontal bar it it not considered so important to put in deep holes. On the contrary a large number of shallow holes, closer together and without the rule of three figuring as to alignment, is found to be best in the long run.

In horizontal hole drilling it is often true that the first three or four feet of hole are drilled much more rapidly than at greater depths; that is, as the hole gets deeper the working of the drill is obstructed by the cuttings which are not so easily freed, by the friction of the long steel upon the walls of the hole, by the running of the hole out of line

and by the excess of labor put upon the rock drill to reciprocate the heavy, long steel. Another disadvantage is that deep holes are not usually as large in diameter at the bottom as shallow holes, hence there is less concentration of explosive where it is most needed.

Shallow holes well filled with dynamite break up the material better and are more apt to throw from the face, while the deep holes dislodge heavy masses, which sometimes must be again broken up before handling.

An interesting record bearing upon this subject is given by Mr. John P. Ramsey in a recent issue of *Engineering-Contracting*. Mr. Ramsey states that in a portion of the work for the construction of the New York Aqueduct the deep hole method was first used in driving the headings. He says: "We drilled 19 holes 10 feet deep for the dry-side and break-down holes, and six holes 9 feet deep for the cut holes." One of the difficulties revealed by experience was that the deep holes interfered with other details of a regular working schedule; that is, the drilling took almost a two-shift period while the other operations only some 5½ hours, and having no working schedule the men were inclined to lag behind. Furthermore, the drill holes were so deep that the explosion did not pull to the bottom of the hole, resulting in a loss which Mr. Ramsey estimates as some 25 per cent. of the holes. He says at times it was necessary to shoot the cut three or four times before the blast was effective. He also speaks of the difficulties encountered by the steels sticking, usually after the hole was 8 feet deep.

In order to improve the service experiments were made with holes of different depths, and it was finally decided to use holes of 6 feet depth for the side rounds and 5 feet cut; the result of this change in the system was that they now get two rounds during the 24 hours, while before they got only one and a fraction round in the same time. The new system gives them a consistent working schedule, the men doing the same work day after day and thus becoming more efficient. Tables are given which show that the reduction of feet actually drilled per yard of rock removed was 15½ per cent., and a saving of lost holes per yard of rock removed was 46 per cent. Almost ½ a pound of dynamite was saved per yard removed, and the final cost of the work showed a saving of 69 cents a yard, together with an increased yardage of 11 per cent. Mr. Ramsey concludes with the statement that "this is sufficient proof that the shallow hole is more economical than the deep hole in driving headings."

THE BALANCED LIFE*

By J. F. Kemp.

One day in the month of August last, I sat down on the summit of a high ridge in Swedish Lapland, far within the polar circle. It is always an unusual experience for a dweller in our latitudes to look away from a commanding peak over these far northern landscapes. They are in themselves lonely in the extreme, and except in unusual cases, almost without visible life. The scattered communities of Lapps, with their herds of reindeer, or perhaps, in favorable meadowlands, a venturesome family or two of Finns, are all that can be normally expected. The surface is an expanse of lake and bog, with now and then a stretch of higher ground and occasionally a hill. The trees are stunted and gnarled by the storms and cold, and the smaller vegetation hugs the ground in a thick mat. And yet, right before my eyes, and not ten years old, was a town of 7500 inhabitants, with hotels, shops, comfortable homes, and school-houses, as good as anything in our latitudes, and a thousand children in them, with pictures, maps, and even some well-executed works of art upon the walls. I really saw a community in the making—the embryo of a little State. It made a profound impression upon me. Now, a community in the making is not an altogether unaccustomed sight to us in America. We who have been in the West have seen it often, and some of us have shared in the process. But in our latitudes the conditions usually permit the growing of those things which are good for food, or shelter, or warmth. The days are not twenty-four hours long in summer and no hours at all in winter. The frost does not come on the last of August, nor the snow in September, and remain till May or later. The water-pipes are not of necessity laid eight feet underground to pre-

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*A chapel address delivered to the students of Columbia University.

vent their freezing, nor are they bedded in non-conductors against the all-pervasive cold of winter. We seldom reach the almost irreducible minimum of which I speak. The ridge on which I sat constituted one of the largest and richest bodies of iron ore yet discovered, and the cause of the railway and of the flourishing town was the plan to mine the ore and ship it to fill the hungry throats of furnaces in Europe and America. And when I thought of my friend of twenty years standing, who was the one who had developed it all and who was now the manager—realizing his almost impossible dreams—I could not help thinking of the position he held as the leader of this community so far from others of its kind. Seven or eight thousand people to be fed, clothed, warmed, educated, employed, and welded into a unit.

On that summit in Lapland my thoughts ran over the ocean to our beloved university, and I could not help seeing in my mind's eye the long procession of engineers who have gone out and who have in some cases, I well know, had the duty and responsibility of organizing similar communities. A mine or a manufactory is always the foster-mother of a community. It furnishes directly or indirectly all the means of subsistence. The manager carries many responsibilities other than the mere business. Away off in Lapland, as I looked over the town of Kiruna, I could not help thinking of the importance of giving it and every similar community an individuality, a character, and a solidarity as the years pass. The life is more than meat and the body than raiment. The daily task must be performed, indeed, the daily wage must be earned, the commercial organization must be perfected, but after that, and beyond all that, a community of feeling must be fostered, an interest of man in man must be established, a life of the spirit must be developed to hold men and families together. While we work in our laboratories, learn to construct our beams and girders, build our railways, smelt our ores, make our profits, and all that, it is not altogether with these material objects that our graduates must deal, but with families and communities and all their varied interests. Pig iron, steel rails or beams, and profits, are not the whole story, but the welfare of men, women, and children is equally involved. This latter responsibility no manager can escape.

DRAINING COMPRESSED AIR

By Frank Richards.

It may be well at the beginning to call attention to the wording of the title of this article. It relates not to the drying but to the draining of the air, the significance of which distinction it is hoped will be evident later.

In the use of compressed air, especially where it has to be transmitted any considerable distance from the compressor to the point, or more frequently the several points, where it is to be employed, there is still in too many cases serious trouble caused by the condensation, and often by the freezing, of the moisture carried by the air. This water trouble has been familiar to all users of compressed air from the beginning, and the cause of the presence of water in the air, and the conditions necessary for its elimination are quite generally understood. As to actually getting rid of the water, however, if not entirely, at least to beyond the stage of annoyance, there is still some of the too familiar difference between theory and practice which so often results from the incompleteness of the former as applied to a specific case.

One of the greatest of the world functions of the atmosphere is the conveying and the distributing of water all over the earth. This is a work in which it is constantly employed, so that when we interrupt it in its work by seizing portions of the air to use for other purposes, it does not drop its water to do our bidding but brings the water along with it, so that all air when we take it into our compressors contains a considerable proportion of moisture.

Normal atmospheric air is usually not completely saturated with moisture, but for any combination of relative volume and of absolute temperature there is always a fixed point up to which it will continue to absorb water if in contact with it, and beyond which it will immediately begin to give up the excess of moisture. Either a change of volume or a change of temperature will immediately change the moisture-carrying capacity of the air. In the operation of compressing the air we violently change both of the great conditions which determine its capacity of humidification, and it might be expected consequently that released water would be at once in evidence. It happens, however, that the two conditions which are so greatly and so suddenly changed

by the compression of the air work against, and largely neutralize, each other, so that the water in the air up to this point is not likely to show itself. As the volume of air is reduced, as it is often to one-fourth or even to one-eighth of the normal by a single compression, the water-carrying capacity of the air is also proportionately reduced, or it would be were it not that the air is at the same time heated by the compression, and the rise of temperature increases the thirst of the air more than the reduction of volume would change its capacity.

The moisture in air up to the point of saturation is perfectly transparent and invisible, but immediately that the saturation point is passed some of the moisture is condensed and is distributed through the air in the form of minute globules of actual water, which may not be individually visible, but which are so when the super-saturated air is seen in the mass.

How suddenly water may change from the invisible to the visible, or from the vaporous to the liquid state, I learned as a boy when I used to watch the running of a glass steam engine. This was a wonder (for its time, more than 50 years ago) which used to be exhibited by a traveling troupe of glass-blowers. It was a complete beam engine like a steamboat engine, with steam boiler heated by an alcohol lamp and a jet condenser and air pump, all of perfectly transparent glass and illuminated so that the true inwardness of all was perfectly visible. You could see in the boiler the water in violent agitation and in the condenser the jet of cold water squirting in, with a cycle of fluctuation corresponding to the revolution of the engine, and also the continual removal by the "air" pump of the accumulating water in the condenser; but in the boiler and in the condenser, and all the way between them, there was no visible fluid movement, except for a single instant of each stroke, this invisibility of the steam making the operation of the engine as a whole to seem as absurd, and the connection and sequence of cause and effect as lacking, as when one gets a glimpse into the window of a ballroom when the waltz is in full swing without being able to hear a note of the music.

The exceptional moment noted was just when the exhaust occurred in the cylinder, and then like a flash it was filled with fog, so that as one would say, the steam became visible, although in fact the steam, or that portion of it which became visible, had ceased to be steam and was instead water of condensation which had become so by giving up its heat to momentarily sustain the vaporous condition of the other portion.

The vapor of water when it is mixed with air is invisible, just as it is when it is not mixed with air, and it becomes visible in the same way when condensation of a portion of it occurs.

I have often wished that we could have some compressed air pipes of glass, or at least some peep holes by which we could see inside the pipe. When the compressed air is first discharged from the compressor it is hot, and being hot it is not oversaturated, and therefore we may assume the air to be perfectly transparent. If, however, the compressed air is then cooled down to normal temperature the point of saturation will be passed, some of the vapor will be turned to water, and then there will be some visibility to the entire mass.

This cooling of the air, with the consequent condensation of a portion of the water in it, may occur immediately upon its leaving the compressor if the air is passed through an aftercooler, or it may occur gradually and be completed at a considerable distance from the compressor if the air is only slowly cooled by its flow through the pipes. In either case the water is still in the air, and the change of the water from the vaporous to the liquid state has not got rid of it.

It is assumed by many that if an aftercooler is used, and if the air then goes from the aftercooler to a receiver, it will there give up its suspended water, but this is found not to be true to any great extent. We may assume that the minute globules of water are distributed through the air just as particles of dust might be, and that although they are heavier than the air it must take time, and perhaps much time for them to settle and separate from the air, especially when it is moving rapidly through the pipes.

The globules of liberated water still unprecipitated from the air differ from dust particles in one important particular. Dust does not attach itself to anything as it is carried along, and has nothing but its weight to hold it, even when it settles at the bottom of any pipe or channel through which it may be

blown. Water, however, wets and clings to everything it touches. In flowing through pipes the air has a rolling rather than a sliding motion, so that practically all of it somewhere comes in contact with the walls of the pipe, and if there is free moisture in the air the surfaces will be wet by it, and the water will accumulate and trickle down, and flow in a stream along the bottom, and pockets may be placed in the pipe at the low points, and here the water may be drawn off from time to time.

If the temperature of the pipe be only a few degrees below the freezing point the water contained in the air, instead of trickling down the interior will freeze fast just where it touches, and thus it may accumulate in successive layers until the internal diameter of the pipe is much reduced or the flow of air is even choked off entirely. This is by no means unfamiliar experience with some installations in the winter, and constitutes a serious trouble.

The wetting and clinging habit of water makes it quite possible to construct compact separators which are effective in removing released water immediately that the air, by passing through an intercooler or otherwise, is brought to the favorable condition of high pressure and low temperature. In such separators baffle plates are employed, and the water-laden air wets these plates and the water drops or runs down from them and accumulates at the bottom to be drawn off.

Whatever the arrangements employed, it is always to be remembered that provision must be made or opportunity must be provided not only for the condensation of the superfluous moisture in the air after compression but also for draining it off or for taking it out of the air.—*Engineering Record.*

THE NASCENT OXYGEN THEORY IN BLEACHING

One of the reasons to which hydrogen peroxide is believed to owe its strong oxidizing properties is that the oxygen is set free from the peroxide exactly at the spot where it is to be used and is in what chemists call the "nascent" condition, that is, the oxygen atoms have not formed any combination among themselves, so that all their energies are available. It must always be remembered when bleaching or taking stains out of any fabric, that the oxygen atoms are no respecters of persons, so to speak, and will oxidize anything that is open to attack, whether it be the stain you want removed or the coloring matter with which the garment is dyed. Nevertheless, the majority of dyes are less readily open to attack as a rule than the matter which causes the stain, so that if the launderer proceeds judiciously he can generally succeed in removing the one without interfering much with the other. The important thing in applying all bleaches and stain removers is to confine their actions as closely as may be to the spot where the stain rests, and to rinse them out directly their work is accomplished, before they have time to turn their attention to the coloring matter in the garment.

BLOWING WINDOW GLASS

In a few years not a pane of glass will be made by hand; as the glass industry, from being one of the most backward, is becoming one of the most progressive, and the possibilities for the scientific man and the inventive genius are great, as the field is practically new and has great opportunities for development.

A few years ago glass manufacturers sought, and paid big salaries to, "master teazers" (men who superintend melting tank and mixture of materials) who were the alchemists in glass, and who, three or four times a day, threw into the tank a mysterious secret powder that was supposed to purify the glass. Now the chemist has applied pyrometers to keep the temperature even and pays attention to the purity of the materials, so the old master teazer has lost his mysterious importance.

MELTING RAW MATERIALS. LADLING.

Glass is melted and purified for working in a large tank, averaging about 20x60 feet, and built of fireclay blocks a foot thick and with a roof of silica brick. The general construction of the tank is similar to that of a regenerative open-hearth steel furnace, the fuel most commonly used being natural gas, and the direction of the flame being periodically reversed, so as to recover the stack heat in firebrick checker work, and also to prevent burning out the passages.

Raw materials are generally mixed by hand, but a few of the more progressive plants are now employing machinery to mix and deliver the batch to the tank, somewhat as an automatic stoker feeds a boiler, care being taken that it is thoroughly mixed and placed in the

tank with as little disturbance as possible, as, if thrown in carelessly, the flying dust of the flux would assail the walls and roof of the tank.

The ladle used in dipping the glass from the tank is a hemisphere of pressed steel, 20 to 25 inches in diameter, a quarter of an inch thick; to which is attached a stout pipe handle about 14 feet long, and a side handle projecting from this at right angles, for dumping. The ladle is supported from a crane in a loose collar, which allows movement in all directions. The ladle is made hemispherical because other shapes were found to produce unequal cooling of the mass, showing what trivial defects become serious matters in glass manufacture.

At a signal from the machine operator, the ladler and his assistant approach the tank with the ladle bottom side up. When the ladle is a few feet from the tank the door is raised and the ladler shoves the ladle totally inside the tank with the rim of the ladle, now upside down, just over the surface of the glass. Then, turning the ladle, with the main handle as the axis, it is filled by cutting (so to speak) a hemisphere of glass out of the tank with the least possible disturbance. If this part of the operation is done carelessly, or with a dipping motion that allows the glass to flow into the ladle, the tendency is to form air bubbles and unequal cooling strains, and, if persisted in, it will mess the glass up to an unworkable state. If air bubbles are formed in the tank, they require hours and days to burn out, and if formed in a ladle of glass, a bubble as big as a pin head will draw the length of a 30-foot "roller" (as the cylinder of glass is called), and be clearly visible. This being a defect, many bubbles will make the roller worthless.

To return to our ladler; as the semi-rotation of the ladle is about completed, the ladler lifts it out of the body of glass, and tries to do so in such a way that the drip that forms on the ladle edge last leaving the surface of the glass is cut off. This can be done so that no drip is left.

Removing the glass from the ladle to the machine is the most important part of the ladling, and is accomplished in one of two generally approved methods. The idea in both is to remove it with as little disturbance as possible and to make the necessary disturbance equal in all directions. The more generally used method is to start to pour on one side of the pot, and then, by moving the ladle over the top of the pot, the glass is placed somewhat as a pie is put on a plate by slipping the pan from under the pie. This method causes greater unevenness of flow than dropping the mass in the center, but eliminates the liability to form air bubbles, and brings the drip to the edge of the pot where it is practically harmless.

GLASS-BLOWING MACHINES.

The principal methods of manufacturing window glass by machinery are the cylinder-pot-drawing machine, drawing cylinders directly from the tank, and drawing the glass in a continuous sheet directly from tank. Of these, the sheet machine, although unperfected, is the most nearly ideal, as it eliminates the ladling and flattening necessary by the first method, thereby producing a pane of glass of unequaled brilliancy. The cylinder machine, drawing direct from the tank is the ideal cyl inder machine, as it eliminates the ladling process, but so far has not been perfected so as to compete with the pot machine. The cylinder-pot-drawing machine is the one drawing glass commercially to-day, and is described in general as follows:

As inferred from the name, the pot forms the principal part of the machine. It is a shallow pot about 4 to 6 inches deep and 36 to 40 inches in diameter, having a uniform thickness of 1½ to 2 inches. It is made of specially high-grade fire clay imported from Germany, the clay going through months of preparation before the pot is ready to put in the machine. Some of these operations are grinding, ageing for several months and tramping with bare feet. This latter process seems rather mediæval at first glance, but it is the only one possible to accomplish the purpose, that of removing air bubbles and unground pieces of clay or stone. During all this period it is kept at a certain degree of moisture by being covered with cloth and sprinkled day and night.

Figs. 1 and 2 show sectional views of two successful pot machines. In Fig. 1 the pot *A* is double, and reversible on trunnions, and the principle of the machine is that while one side is filled with glass and cylinder being drawn, the other side is being cleansed of "bad glass," or undrawn residue, by the action of heat from burners *B*. These burners are also used to

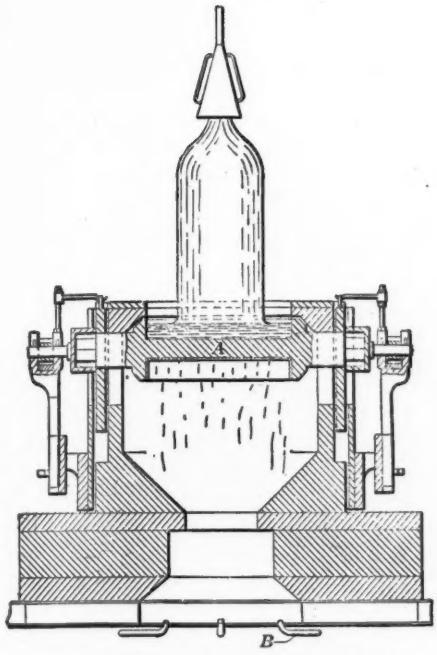


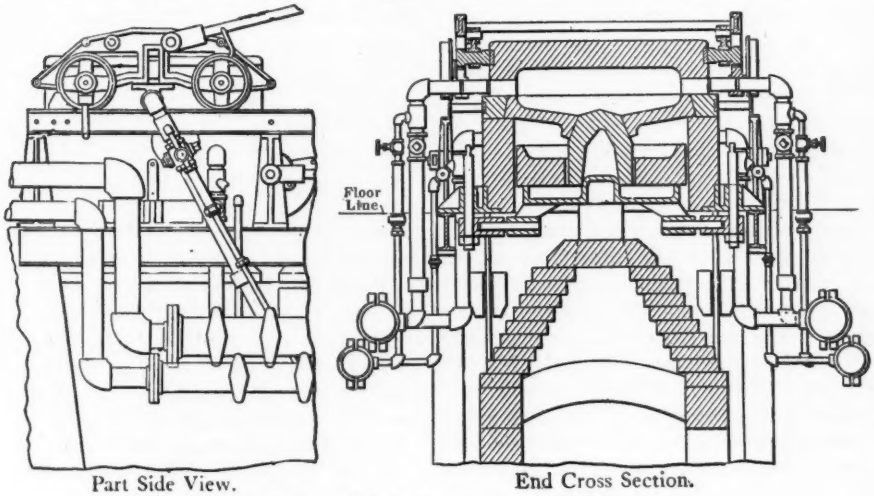
FIG. 1. SECTION OF POT MACHINE.

keep the pot in a heated condition, which tends to keep the molten glass in the upper side of the pot at an even temperature. The drawing and cleansing thus being simultaneous the machine operation is continuous. These pots must be put into the machine already heated to a white heat, and inserted quickly to prevent sudden cooling and conse-

Fig. 2 shows a part of the general arrangement and cross-section of the other machine, in which two separate pots are used to a unit. Each machine consists of three component parts: two duplicate furnaces, each containing a pot; and a furnace hood. As shown in sectional view, the pot has a hole in the center which is closed by a movable fireclay plunger. Beneath the pot, in the furnace proper, air-blast gas burners are inserted. The furnace hood consists of a fire-clay covering having telescopic pipe connections for the burners, and mounted on a carriage that allows of the hood being moved as a whole from one pot to over the other. While a cylinder of glass is being drawn from one pot, the bad glass is being melted from the other. The raising and lowering of the plunger closes and opens the bottom of the pot as required.

THE BLOWPIPE CARRIAGE.

Over these machines is placed the structural-steel framework which supports the "ways" for the blowpipe, or drawing carriage. The ways consist of 2-inch cold-rolled steel shaftings, two to each pot of each machine, spaced three feet between centers. Between the shafts and the arms is also a semi-circular galvanized-iron shield, clearly shown in Figs. 3, 4 and 5; the object being to protect the roller from all air drafts while being drawn and cooled. On the ways are the blowpipe carriages, one of which is shown in Fig. 6. The movement of these carriages is controlled by cables from hydraulic cylinders supported on the structural framework in the rear.



Part Side View. End Cross Section.

FIG 2 SECTION OF TWO-POT MACHINE.

The control of all the carriages and of the air supplied to the blowpipes is concentrated at the operator's stand, which is located about 10 feet in front of, and central with the machines, as shown in Figs. 3 and 4. Fig. 7 shows a diagram of the air and water system for the blowpipe carriage. The water is delivered to the main line at 150-pounds pressure, maintained constant by an accumulator which automatically starts and stops the pump as needed. This water operates the plunger, the stroke of which is half the travel of the blowpipe carriage. The plunger is connected to the carriage by a ½-inch steel cable running over pulleys on top of structural framework.

Air is supplied to the main air line at 6 to 7 ounces per square inch, by a steel pressure blower, and this pressure is maintained constant by an aërometer whose action is automatic on the pressure blower, increasing or decreasing its capacity as needed in the main line. From the main line are taken branches for each blowpipe carriage.

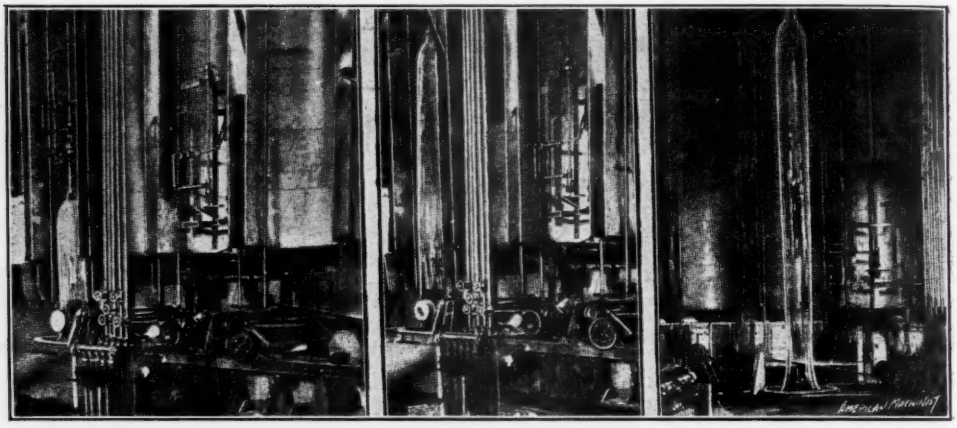


FIG. 3. FIG. 4. FIG. 5.

THE BLOWING PROCESS.

At a signal from the operator, the ladler and helper start the ladling process described above; at the same time the blowpipe man takes a blowpipe from the heating furnace where a number of them are being heated to a cherry red on the lower half of the Norway iron head. Placing the blowpipe in a saddle, he cleans the head of all scale and glass with a rough file and makes sure that the air hole is clean. Having done this, he brings the blowpipe to the carriage and attaches it to the air pipe, and while this latter is being done the furnace-hood man removes the hood from the pot in which the ladler is to pour the glass.

The pipe being filled, the operator then lowers the carriage until the heated head of the blowpipe enters the molten glass about an inch, allowing this to stand a few seconds for the glass to adhere. He then very carefully turns on the air until a bubble appears underneath the blowpipe. This latter part of the operation must be very carefully done, lest too much air be turned on, blowing out to one side and making it necessary to dump the whole pot of glass; as once blown out, it is useless to try to form a new bubble. The bubble being formed, the carriage is started slowly upward, with the air shut off for an instant and then gradually turned on again, and the glass begins to bulge out, forming a neck similar to that of a bottle. When the neck is fully formed, the air valve is left as it is at this point and the speed of the drawing is slightly increased, averaging about 40 inches per minute, depending upon the quality of the glass, temperature and thickness desired.

From the time the neck is formed until the cylinder is drawn, there must be a gradual and scarcely perceptible increase in the air supply and speed of drawing, on account of the varying condition of the air pressure and the temperature of the glass. At the start of the cylinder, the entering air strikes the surface of the molten glass and is expanded, thereby increasing the pressure. As the cylin-

der is drawn, the mouth of the blowpipe recedes from the surface of the molten glass and the entering air becomes less and less heated, requiring a greater volume of entering air to maintain the pressure. Also, as the glass in the pot is each instant becoming cooler, it is necessary to draw faster in order to keep the thickness of the glass constant.

The flow of air is increased by means of valve *A* on carriage, Fig. 6, which has a long, narrow slot automatically controlled by a piston as the carriage moves upward. Motion is communicated to the piston by the levers and links shown, actuated by a rack. For changing the speed of drawing, the best method has been found to be manual; that is, by the operator opening the value to the hydraulic cylinders as required, as the ever changing atmospheric conditions forbid any set speed of drawing.

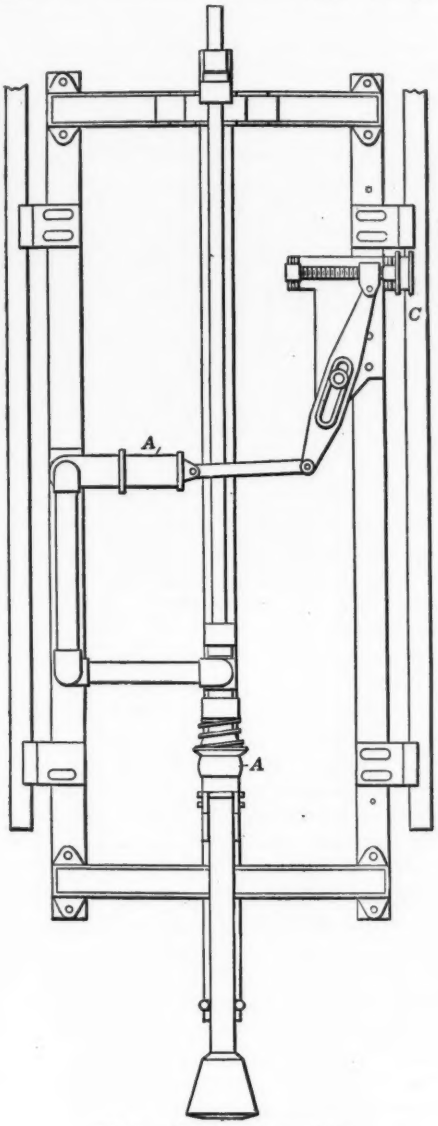


FIG. 6. BLOW-PIPE CARRIAGE.

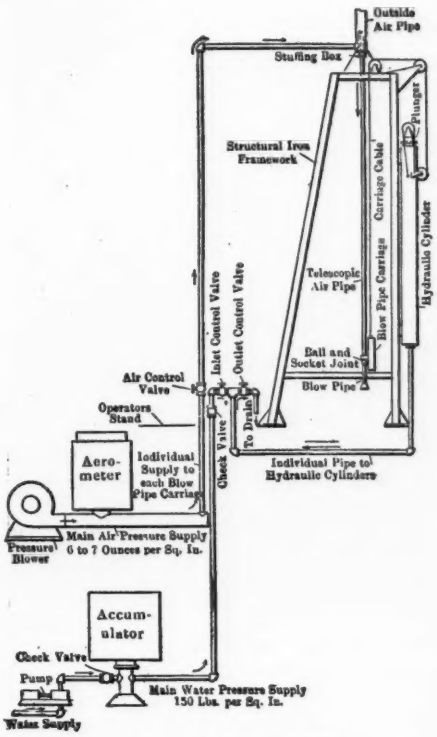


FIG. 7. AIR AND WATER SYSTEM.

Figs. 3, 4 and 5 show various stages of the cylinder while drawing; the latter one showing the cylinder drawn to full length and ready to be severed from the pot. This is done by shutting off the air supply, causing the cylinder to draw in again near the pot, and then pressing a sharp-pointed rod, slightly dampened on the point, against the neck just formed; a crack is then started which, by suddenly increasing the drawing speed, is made to extend clear around the neck, thus severing the cylinder from the pot.

The cylinder is now taken down and laid on horses, to be cut in suitable lengths for flattening. Taking down is accomplished with asbestos-covered tongs placed around lower end of

FIG. 8.

cylinder, and carried by a pulley on a rope. The blow pipe swings in a ball-and-socket joint, and the next operation is to remove the blow pipe from the cylinder. This is done with a moistened, sharp-pointed instrument, as for the lower end.

CAPPING WITH AN ELECTRIC WIRE.

Immediately upon being laid on horses, the two rounded and rough ends are capped off and the cylinder is cut into lengths as desired, depending upon the size of sheets into which the glass is to be cut after flattening. This cutting or capping is done by encircling the cylinder with a small (about 1/32 in.) iron wire, heated to a dull red by an electric current. The current is then turned off and the cutting is performed by a moistened, pointed rod. These short lengths of cylinder are then placed on other horses, to be cracked open lengthwise. This is done by using a long, heated rod, shaped like a knife-edge planimeter, following this with the moistened, sharp-pointed rod.

Being split, the cylinders are taken to the flattening oven where, after being gradually heated almost to the collapsing point, they are spread out and smoothed by a moistened wooden block on a long handle. After this, they pass through the "lehr," or oven, in which they proceed from a highly heated to a cold condition, so as to temper the glass. This is followed by plunging into an acid bath to clean the surfaces.—*American Machinist.*

VENTILATION EXPERIENCES

In the "Plenum System," the air to be used in the building is drawn down a shaft provided for the purpose, taking the purest air obtainable in the neighborhood. It is drawn in through a hole in the outer wall of the building, by the aid of a fan working just inside. It is cleaned, washed, dried, humidified, cooled or warmed, and delivered to main ducts, just inside the building, and from them to branch ducts leading into the rooms to be ventilated. Other ducts lead from the rooms to be ventilated, joining larger ducts, which lead the air to an outlet shaft, as far removed from the inlet as possible. The working of the system appears to be remarkably successful. In the Birmingham General Hospital, for instance, there were no draughts. One was not conscious of any difference in temperature, or any unpleasant draught of air, when passing from a ward to the corridor. There was no unpleasant smell either during the time when dinners were being served or in the time immediately afterwards, when offensive smells are too often prevalent. There was none of that smell of drugs that is so often found all over hospitals. Though the air of Birmingham in the neighborhood of the General Hospital is hardly what one would call ideal, and though Birmingham itself is subject to fogs, and its atmosphere is as full of smoke as most manufacturing towns, the general atmosphere of every room supplied with air in the hospital was decidedly good.

There was one drawback however. I had talks with a number of the physicians and surgeons and nurses in the establishment. Most of them liked the system, but would not have it in their own quarters. One of the medical staff also told me that he found that his convalescents did not get on as fast as in a hospital ventilated in the ordinary manner by natural ventilation. They got on well, he said, up to the point of convalescence, and then they hung fire. At the Manchester School of Technology, and in the Midland Hotel, where I have since stayed on several occasions, there is apparently no complaint whatever. The air in the building is always of a comfortable tem-

perature, and there appears to be none of that lassitude that the doctors and nurses complained of when the system was employed for their own quarters. Enquiry also into the ventilation of operating theatres disclosed the fact that surgeons who have to stand often for a long time, when engaged in a number of operations, and the nurses who are in attendance, get very tired, owing to the warm temperature that is necessary to be observed, and to the accumulation of moisture in the atmosphere.

While at Birmingham, I was also, by the courtesy of the hospital superintendent, allowed to inspect the record which is kept of the temperatures in each ward, and I found that it was uniformly at 63°F. The superintendent explained to me that this temperature was a compromise, that the medical staff had different views as to the temperature that should be carried, and eventually the one named was decided upon. It appeared to me at the time, that this question of the temperature was the cause of the staleness which the nurses and doctors complained of, and of the slowness in convalescence. We know, that for health, we require to sleep in cool rooms, with our windows open, as far as possible, except in very cold weather. And the reason I think is, because the lower the temperature, the larger the weight of oxygen in any given volume of air, and consequently the greater the vivifying effect of the atmosphere. I think that if convalescent wards, and the residential quarters of doctors and nurses were ventilated with air at a lower temperature, very good results would follow. At the Manchester School of Technology, they have control of the temperature in each class room. The engineer in charge told me that the requirements of each class room varied very considerably. One lecturer liked temperature a little bit up, another was better with it a little bit down. One lecturer's throat might be a little relaxed, and so on.

OZONE.

It appeared to me that the matter might even be carried farther, and that either oxygen or ozone might be employed in certain cases, to add to the invigorating effect of the atmosphere, and I suggested it in one of the medical papers. News has since come to me from America, that a system of adding ozone to the air of some of the public buildings has been adopted, and with great success. There are a number of appartus on the market, designed for the manufacture of ozone. All are on very much the same lines. There is an electrical condenser, and a high tension alternating current is delivered to it. Air is drawn through the condenser, its plates being arranged so that this can be done, and a certain portion of the oxygen of the air passing through is converted into ozone. The National Air Filter Co. of Chicago have worked out a number of apparatus, some small enough to be used in ladies' boudoirs, and ranging up to apparatus sufficiently large for the auditorium of their largest theatre, and for their public library. Great complaints had been made about the atmosphere of their public library. It was largely the resort of "out of works," who are also frequently the unwashed, and consequently unpleasant odours were very much in evidence. Germs evidently were also floating in the atmosphere, and the chief librarian had contracted a chronic affection of the throat in consequence. Ozonised air is now delivered into the main duct of the Plenum System, with which the library is ventilated, and the result has been exceedingly satisfactory. The librarian has recovered from his affection of the throat, no odours are present, and the books which had shown signs of deterioration have now ceased to do so. I suggest that something of the kind would be of service in the hot weather, for warehouses, offices, etc., in Calcutta, Bombay, and the large cities of India and the East. Nothing keeps a man up to his work so well as a supply of oxygen, and ozone in moderate quantities is even better. A few years back, I was attending an exhibition in London. Looking through exhibitions, as most of your readers know, is exceedingly fatiguing work. At the close of the day I came to an exhibit of an ozone making apparatus, and I got the attendant to discharge his current of ozonised air over my person for some minutes. The result was very satisfactory. I was very much less tired that evening than I ever remember to have been after a similar day's work.—*Correspondence Indian and Eastern Engineer.*

In early November, 16-year-old Miss Jones lifted 52,800 tons of rock with 400 pounds of explosive. Miss Jones then fried an egg with the same kind of powder scattered on the ground to demonstrate its safety.—*Cleveland Press.*

VERTICAL GAS RETORTS IN ENGLAND

The Bradford city council has just recommended that $155,630 be expended on an installation of vertical retorts at the Thornton Road city gas works. In Germany, it is said, vertical retorts have been very widely adopted during the past two or three years, but Bradford is one of the first towns in England to adopt the system, the merits of which are receiving much consideration throughout the country. Among the advantages claimed for the system, first in importance is the very substantial decrease in the cost of production brought about by the increased yield of gas from a specific quantity of coal; an improved quality of coke is produced; the yield of by-products is increased; naphthalene troubles are largely reduced, if not entirely eliminated; and a vast improvement is effected from a hygienic standpoint. Another advantage also is that a plant with sufficient gas-producing capacity can be put down on half the space occupied by the horizontal retorts, giving a greater area for storing the coke. The labor costs are said to be about one-eighth of those in the use of horizontal retorts.

GLYCERINE

Many years ago, in an obscure mining village in Sweden, an apothecary was making lead plaster in the ordinary way by heating olive oil with litharge and water, when he chanced to notice that the liquid which was mingled with the pasty lead compound had a strangely sweet taste. On further investigation, he found that the sweet taste was caused by the presence of an oily liquid which was dissolved in the water. No such substance was described in the books of the day.

Scheele, the apothecary, knew that he had discovered a new substance. He soon found that this sweet liquid was not the product of olive oil alone, but that other oils and fats would yield it under the same treatment. So he named it the "sweet principle of fats," or "oil-sugar."

More than a century has passed since Scheele's discovery, yet it is but little over sixty years since "oil-sugar" was found to be of practical value, except for a very limited use in medicine. Chemists have given it the more formal name of glycerine, derived from a Greek word meaning sweet.

Every one to-day is familiar with the clear, thick liquid so commonly used for toilet purposes. Its soothing and softening effect on dry or inflamed skin is the quality for which it is best known in most households; but few people have any idea of the variety of purposes to which it is applied.

Among its most striking and valuable properties are its great solvent power, its chemical stability, and its sweetness. Moreover, it is digestible, will not evaporate, and owing to this and its hygroscopic qualities, will prevent the drying and hardening of materials with which it is mixed.

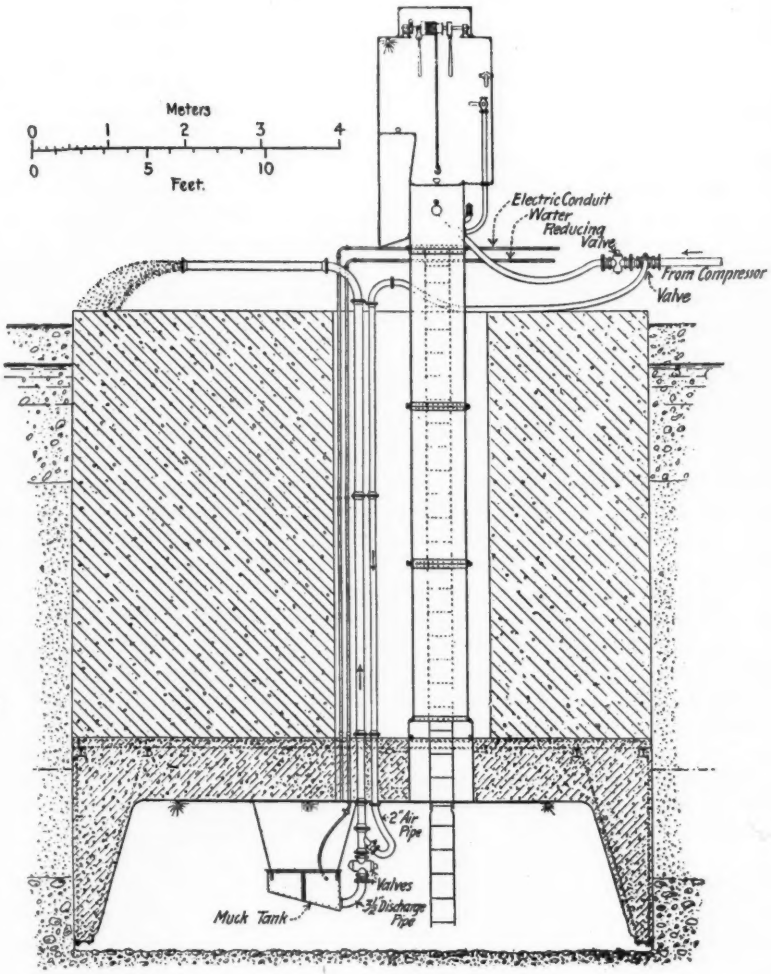
These peculiar qualities make it most valuable in the preparation of medicine, unguents, and various food products, as preserves and mustards; likewise in beer, wines, and other bottled goods, where it is said to act as a preservative. The fact that strong solutions of glycerine and water will not freeze in the lowest winter temperatures has caused its use in our "wet" gas meters.

Some of the more important industries in which it is used are vulcanizing India rubber, silvering and gilding glass, dressing leather for gloves, preserving anatomical and botanical specimens, and the manufacture of what is, perhaps, the most powerful explosive known to science, without whose aid some of the grandest triumphs of modern engineering would have been impossible—nitroglycerine.

In a pure state glycerine is one-fourth heavier than water. After long exposure to a freezing temperature, glycerine will deposit rhombic crystals resembling those of sugar candy. Its boiling point is 490 deg. F. Pure glycerine will burn readily if first heated to about three hundred degrees. It gives a pale blue flame similar to that of alcohol, and to the chemist it is an alcohol.

PNEUMATIC MUCK EJECTOR WITH TWO-STAGE AIR SUPPLY

The cut here reproduced from *Schweizerische Bauzeitung* is a diagrammatic representation of a specialized form of pneumatic muck ejector used in caisson foundation work at Aaran, Switzerland, as described by G. Lüscher its designer. The usual air supply is maintained in the working chamber of the caisson sufficient to resist the water inflow corresponding to the depth, but as pneumatic tools are used in the caisson, an air supply is maintained



PNEUMATIC MUCK EJECTOR.

sufficient to operate them while exhausting into the air of the caisson. The entire air supply is in fact furnished at the higher pressure, while the caisson pressure is controlled by passing that portion of the air through a pressure-reducer.

The ejector comprises a hopper-bottom muck tank, a valved discharge pipe leading from the bottom of the tank to the open air, a valved auxiliary, high pressure air pipe leading into the discharge pipe at an acute angle, and a water pipe for furnishing water to keep the contents of the tank in fluid condition. The tank is made in sections, so as to permit taking it through the air-lock. The discharge pipe as used was 3½ in. diameter, the high pressure air pipe 2 in. The latter pipe joins the discharge pipe at a forward angle of about 45°.

In operation, the tank is filled with muck, and if this is clayey in nature sufficient water is added to enable it to be blown out, while sand is handled without water addition. The discharge valve being kept closed, the auxiliary air value is opened, producing a strong ejector action in the discharge pipe. Then the discharge valve is opened, and the muck is blown out very rapidly. The tank is kept constantly supplied by shovelers; whenever the tank becomes nearly empty the discharge valve must be opened at once, to prevent serious loss of air from the caisson.

The working principle of the apparatus is that the caisson pressure is used only to force

the material far enough for the ejector action of the auxiliary or high pressure air to take hold of it; the latter then does the main part of the lifting.

AN UNUSUAL EXAMPLE OF PNEUMATIC CAISSON WORK

The deep foundations for the new Municipal Building, in New York, are notable for the magnitude of the work and its rapid execution under great difficulties, and for the manner in which perplexing contract difficulties were equitably adjusted. The substructure is designed to carry a 165,000-ton superstructure, rising to a height of 580 ft. above the street, on 106 separate piers. Some of these piers are supported on solid rock and some on sand and quicksand, the latter being without any appreciable variation in the slight settlement they have shown. These foundations have been sunk far below the ground-water level to depths closely approaching the limits for pneumatic pressure work. Thousands of yards of sand and quicksand have been excavated far below the surface without injury to adjacent tall and heavy buildings. Elevated and subway railroad structures, and large gas, water, sewer and electric mains below the street surface were maintained in service with no serious interruption to the heavy traffic of vehicles, pedestrains, and street cars on an important city street which crosses the full width of the building. This work of sinking the piers has been accomplished in about a year at a cost of about $1,500,000 and without serious accident or the loss of life.

The caissons vary greatly in size, form and depth and are of several distinct types, showing the most recent improvements in construction of this sort, together with new features developed to meet the special conditions existing at the site. The working chambers are of steel where the greatest economy of space is necessary, and of reinforced concrete where there is abundance of room, while in intermediate cases wooden caissons, heretofore standard for all but the smallet piers, are used. Permanent wood and steel are almost eliminated from the finished structures and the strength and weight of the concrete were utilized largely in the construction operations.

Rapid and efficient work in a very congested area enclosed by streets with heavy traffic of all sorts has been accomplished by the installation of a battery of steam boilers of over 1,800 hp. capacity, seven large air compressors, 26 hoisting engines, 11 steam pumps, 16 air locks, six concrete mixers, 56 steel buckets and other equipment in proportion, all located within the limits of a 164 by 374-ft. triangular lot. Storage was largely eliminated by the delivery of material only as needed, plant and materials were handled without delay and shifted repeatedly by a system of 26 traveling and movable derrick booms, and extra space was provided by elevated working platforms under which foundation operations could be carried down. Economy and rapidity of construction were promoted by the construction of the deep piers in rapidly shifted forms, entirely above ground, and by building them up to heights reaching a maximum of 60 ft. before sinking.

The piers, with maximum loads up to 5,000 tons, were at first designed to have all foundations carried down to rock, but when it was found that the danger and expense of reaching the deepest rock were too great, additional investigation and practical tests were made on the bearing capacity of the soil and part of the piers were redesigned and proportioned to rest without serious settlement on the sand far above the rock. Fortunately the heaviest and tallest part of the building has rock foundations and it is believed that the loads on the other piers are so well within the tested bearing capacity that no injurious settlement will be occasioned by their final loads.

After the contract had been made for 116 caissons to be sunk to solid rock and the work was well under way, it was decided to eliminate 10 of the piers and modify the design of 30 others, which were to be sunk to a less depth than at first proposed, thus greatly changing the condition and cost of the work. The advantages and disadvantages accruing to both the owner and contractor from these changes were carefully studied; allowances were made for the elimination of very dangerous and costly work, for the loss of reasonable profits, for the delay in operations and change in plans and material, and for fixed and overhead charges. An equitable basis of unit prices was deduced from

the results of this investigation, and the original contract was accordingly modified to suit the new conditions in a manner that was satisfactory to both parties and is believed to afford a valuable basis for the readjustment of future contracts. These results are due to the harmonious efficiency of engineers and contractors, experienced in caisson work and in general construction, unhamperd by interference from the laymen connected with the city administration. —*Engineering Record.*

FOR INCREASING THE EFFICIENCY OF MINING LABOR IN TRANSVAAL

A paper before the Transvaal Institute by Mr. Kenneth Austin, M. E., treats of the above topic. Without going deeply into facts regarding the efficiency of drilling and explosive operations, it is generally admitted that for some time to some a very large portion of the available hand labor will be used in this field for drilling the rock; first, because of the lower cost of the labor; second, because of the smaller diameter of the holes drilled by hand; third, because of the disturbance of the roof being less when small holes are used than where large machine holes are exploded.

Under these conditions Mr. Austin suggests the use of a handy self rotating, well balanced hand drill weighing about 18 lbs., for starting the holes to be drilled, to a depth of 4 to 6 ins. This method is designed to secure:

(1) The correct alinement of the hole for guidance of the laborer.

(2) A less number of hand drills necessary for starting the holes.

(3) A saving of time in starting holes.

(4) The use of the laborer's time in drilling rather than the toilsome process of starting a hole on an angular face.

(5) The placing of a hole in its proper place.

It is estimated that 60 holes a day would be started by the machine.

The machine uses a total of 30 cu. ft. of free air per minute. The hose used is only ½-in. internal diameter, and would be wound on a hose-reel with suitable connection to the air main. When not used for air, the hose may be used for conveying water to wet the broken rock before or during shoveling operations.

It is well ascertained that best results are obtained in breaking ground when the amount of burden roughly given to a hole is two-thirds of the length of the hole drilled and according to the width of the stope, and consequently it is more economical to drill a hole from 48 ins. to 52 ins. rather than one of only 36 ins. length. Experiments carefully conducted in certain stopes on the East Rand have been made, and it was found that a 36-in. hole, under the best conditions only provided a total of a half to one ton of broken rock, whereas the longer holes, 42 ins., 48 ins. and over, provided from 1½ to 2 tons and over of rock, dependent, of course, upon the varying conditions in each stope, as before mentioned. This being the case, any scheme for increasing the length of the hole will directly increase the efficiency of labor, as represented in tons broken per laborer, and also increase the efficiency of that laborer, by assisting him to attain the desired definite results without great expense.

Naturally, some system is required which can be readily adopted without disturbing the mine organization too much, or cause difficulty by adoption. It will be a different method to the present one, and one whereby the mines in charge will drill one day's set of holes in one face of stope, and will be followed by hammer boys the next day, while he prepares another face for subsequent operations. The whole system would be practically one where machinery assisted and developed the efficiency of labor and system of working. It may be said that if machines are used at all, why not use them altogether? This, however, involves the use of more air than required under this method; the setting up of bars to hold drills, and the drilling of larger holes, with the greater consumption of explosive than where the hole is finished for a ⅞-in. diameter gelatine cartridge through the entire length of the hole.

Cost of Air.—The 18-lb. weight automatic rotating machine uses only 30 cu. ft. of free air per minute. Assuming the cost of power supplied to be 1 ct. per kilowatt hour, and that 12½ KW. will compress 100 cu. ft. of air to the desired pressure, namely, 80 lbs. per sq. in. (gage pressure), the cost per air amounts to 1-in. drilled per min. x 6 in. deep x 30 cu. ft. per min. equals 6x30 equals 180 cu. ft. of air, or say 200 cu. ft. of free air per hole. Taking the above factor of 12½ kilowatts per 100 cu. ft. of air compressed the power used would be 2x12½ or 25, say 30 kilowatts.

The advantages obtained by the adoption of the method above described, can be seen if a comparison be made with a first-class mine on the Central Rand where hand drillers are paid 1c. per in. if 42 ins. are drilled, plus a bonus of 6 cts., which amounts to 49 cts. per 42-in. hole. Now if this hole can be increased in depth (thus allowing a greater burden to be placed on it) to say 48 ins. or 52 ins. the extra cost of air, etc., would amount to only 1ct. per hole.

Cost of Plant.—The cost of each automatic rotating drill is $110, and allowing three machines for each miner, the capital cost would be, with hoses and other plant described, say $500 for each set. The machines would wear at least two years and cost $7.50 per month (when working) for repairs. Only one machine would actually be in use, but three have been included in the estimate, so that at any time one could be on the surface for repair, if needed, and one held in reserve by the miner. The daily cost based on the above figures would then be:

Cost of the whole plant, $500.—600 working days in two years equals $0.83 per day for redemption; an excessive figure, because only one machine would be in use.

Repairs per month, $7.50.—26 shifts per month equals 29 cts. per day for repairs. Extra gelatine used, 2 oz. for deeper hole, equals $0.02.

This amounts to a little under 5 cts., total extra cost, to obtain an increase of broken ground amounting to ½ ton or more per hole.

The writer has called attention to the fact that it is not low working costs alone which are to be desired, for it may happen that low working costs do not mean increased profits. It can easily be demonstrated that it is economic folly to strive after low working costs, if the profit is not increased, and he submits that the proposals in this paper will secure all objects, namely, lower working costs, greater efficiency, and, last but not least, larger profits.

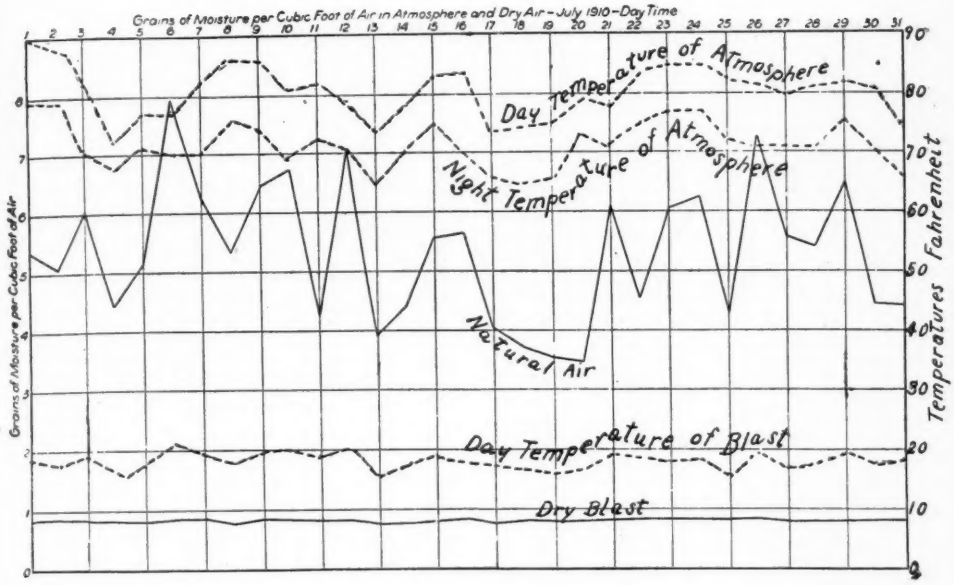
OXYGEN FROM THE ATMOSPHERE

Separating oxygen from the air, says James Swinburne, is not the same as making liquid air. To separate oxygen from nitrogen involves doing mechanical work, which is converted into heat. A rectifying plant may be considered as an apparatus, which takes in heat substantially at the boiling-point of the liquid with highest boiling-point, and gives it out at a lower temperature near the boiling-point of the most volatile liquid. An air separator thus takes in heat at 90° C. abs., gives out heat at about 82° C. abs., and at the temperature of the works, say, 273° C. abs. The Linde process may be regarded as a rectifying plant of this sort, and a thermodynamic engine, in which a gas is compressed so as to liquify at 90° C. abs. under pressure, and to evaporate at 82°, thus supplying the heat at the boiling-point of the oxygen, and absorbing it at the boiling-point of the air. Such a process is generally considered irreversible, but is in fact nearly reversible and therefore economical. Assuming an efficiency of 40 per cent., the cost of oxygen comes out approximately one shilling (25 cents) per ton on a large scale. This ought to lead to its use in blast-furnaces and other cases where an extra high temperature may be important.

WONDERFUL NATURAL FIBRE

Take a certain kind of glass, soften it by heat, draw it out into fine, flexible thread, weave it with care into a fabric incorruptible as to decay and the action of most acids, but not as to heat, and you have approached the limit of man's effort to produce a mineral fibre. Nature makes a shrinkage crack in a mud-like stone, fills it with water, dissolves a little of the mud in the water and crystallizes the whole crack full of threads which are much finer, more flexible, and stronger than the glass fiber, and in addition thereto capable of withstanding a temperature of 2000 to 3000° F. Remembering that the water combined in these fibers runs as high as 14 per cent. of the whole weight, one is forced to the conclusion that some of nature's processes are "past finding out."

The Greeks named this fiber "asbestos" (unquenchable, unconsumable); the Romans made cremation robes of it, and Charlemagne astounded his gaping courtiers by casting his well-soiled table cloth into the fire and withdrawing it, clean and white for another feast. Nor has it been many years since an otherwise respectable and industrious lumberman was accused of witchcraft and run out of a camp in the Canadian woods because he persisted in washing his socks in the stove, instead of by more conventional methods.


Grains of Moisture per Cubic Foot of Air in Atmosphere and Dry Air – July 1910 – Day Time
Grains of Moisture per Cubic Foot of Air
Temperatures Fahrenheit
Day Temperature of Atmosphere
Night Temperature of Atmosphere
Natural Air
Day Temperature of Blast
Dry Blast

RECORD OF COOLING AND DRYING.

SUCCESSFUL AIR COOLING AND DRYING

For results most nearly approaching perfection we naturally look to the records of laboratory experiments, and the diagram which we here reproduce from *The Iron Age,* with our addition of the temperature lines, has its first interest for us in that while its showing is so remarkable it represents what is accomplished in operations which are upon the largest scale known to our industries. Our readers are mostly familiar in a general way with the Gayley Dry Air Blast, which has accomplished such economies in blast furnace practice by the device of refrigerating and drying the air.

The data here presented are furnished by Mr. Gayley from a Western plant for the month of July, 1910. The summer months represent the period of greatest humidity and highest temperature, and for that reason they furnish the best opportunity for demonstrating the efficiency and value of the process. While the atmosphere, as shown by the figures, varies widely in both temperature and moisture, the variations in the dry air are within narrow limits, and approach as close to uniformity as seems possible to obtain in a mechanical device that is treating 40,000 cu. ft. of air per minute.

The amount of work done by a dry air plant in mid-summer in removing moisture is ordinarily not fully comprehended by simply expressing the moisture content in grains per cubic foot of air. Taking, for example, a very humid day, July 6, when the moisture as shown in Table 1, averaged 7.90 grains for the day and night, there would have entered the furnace under natural air conditions 7797 gal. of water in the 24 hours. This would be the equivalent of 185.6 barrels. The dry air on the same day contained only 0.86 grain, and the quantity of water entering the furnace was accordingly reduced to 849 gal., thereby eliminating 6948 gal., and saving the fuel necessary to dissipate it. Taking again the day with the lowest humidity, July 19, when the moisture for day and night averaged 3.45 grains, the furnace would have received 3410 gal. of water, but the dry air carried in only 809 gal., representing an abstraction of 2601 gal. Thus, even on days of relatively low humidity, the quantity of water extracted is very large.

The amount of water extracted through the dry air process expressed in gallons as seen in Table No. 2 is very impressive, and will be particularly appreciated by practical blast furnace managers who are familiar with the cooling effect produced in the furnace hearth from

	Grains of moisture per cubic feet air.				Temperature (Degrees F.)			
1910.	Atmosphere.		Dry blast.		Atmosphere.		Dry blast.	
July.	Day	Night.	Day.	Night.	Day.	Night.	Day.	Night.
1	5.37	5.46	0.85	0.84	91	79	18.5	19
2	5.09	6.10	0.86	0.86	89	79	18	19.5
3	6.06	4.96	0 85	0.83	82	71	19	18.5
4	4,43	4.56	0.84	0.81	72	68	16	16
5	5.14	5.99	0.82	0.85	77	71	17.8	19
6	7.96	7.84	0.86	0.86	77	70	21	21
7	6.24	6.56	0.86	0.85	82	70	19.5	20
8	5.31	6.59	0.79	0.83	86	76	18	20
9	6.47	6.97	0.86	0.82	86	74	20	19
10	6.76	5.37	0.84	0.82	81	69	20	18
11	4.25	4.89	0.82	0.77	82	73	19	18
12	7.03	5.54	0.84	0.79	79	71	20.5	19
13	3.91	4.20	0.78	0.80	74	65	16	15.3
14	4.40	5.15	0.79	0.80	78	70	18	17.6
15	5.57	6.24	0.81	0.83	83	75	19	19
16	5.68	5.51	0.85	0.81	84	70	18	18
17	4.03	4.31	0.79	0.85	74	66	17	17 7
18	3.73	3.54	0.81	0.83	75	65	17	14.7
19	3.54	3.37	0.80	0.84	75	66	16	15
20	3.48	4.35	0.81	0.85	79	73	17	18
21	6.07	6.33	0.82	0.82	78	71	19	17.5
22	4.52	4.96	0.83	0.82	84	75	18.5	18
23	6.04	5.87	0.83	0.82	85	77	18	17
24	6.21	6.61	0.84	0.85	85	77	18.5	19
25	5.28	5.16	0.83	0.83	83	72	16	17
26	7.28	5.79	0.85	0.83	82	71	19.2	18
27	5.58	6.10	0.80	0.84	80	71	17	18
28	5.31	5.74	0.82	0.82	81	71	18.3	18.7
29	6.47	7.06	0.82	0.84	82	75	19.2	20
30	4.43	4.74	0.83	0.79	81	70	18	18.5
31	4.40	4.29	0.81	0.78	75	66	18.5	17.5

TABLE 1.

small leak from a tuyere or bosh plate. The diagram shows graphically the grains of moisture in the atmosphere and the resulting dry air. The uniformity of the dry air speaks for itself, as to its value in a process so delicate in adjustment and so variable as a blast furnace.

When the results of dry air were first made public in 1904 it was thought by some that the economical results obtained were not due so much to low moisture in the dry blast, as they were to creating conditions of uniformity in the moisture—that is, if the moisture was maintained uniformly at 2 to 2.50 grains or 3 grains, the results would be practically as good as if it was reduced to 1.5 grains. This, however, does not appear to be borne out in actual practice, as the best results are obtained when the moisture is reduced below 1 grain per cubic foot of air, and is markedly greater at 0.75 grain than at 1.50 grains. The reasons for this do not seem at present to be clearly understood, although it has been demonstrated in practice.

The conclusion reached from the experience of the past six years is that dry air blast conservatively considered will effect a saving of 10 per cent. in fuel, with an increase in output of 12 per cent., and the product can be increased beyond this at the expense of fuel saving, and vice versa. The tendency in some cases is to increase the output at the expense of fuel saving. At one works the saving in

July, 1910	With natural air. Gallons.	With dry blast. Gallons.	July, 1910.	With natural air. Gallons.	With dry blast. Gallons.
1	5,349	834	17	4,116	809
2	5.517	849	18	3,588	809
3	5,438	829	19	3,410	809
4	4,432	814	20	3,915	819
5	5,488	844	21	6,119	809
6	7,797	849	22	4,678	814
7	5,428	844	23	5,876	814
8	5,873	799	24	6,327	834
9	6,033	829	25	5,152	819
10	5,981	819	26	6,450	829
11	4,511	785	27	5,764	809
12	6,203	804	28	5,453	809
13	4,002	779	29	6,184	819
14	4,713	785	30	4,525	799
15	5,828	809	31	4,288	782
16	5,522	819			
Total, July				164,560	25,254
Equivalent in barrels of 42 gal. each				3,918	601

TABLE 2.

coke was 7.5 per cent. on dry air, but concurrently the output was increased by 23 per cent. Thus the dry air blast not only reduces the cost of pig iron, but it also creates uniformity in the furnace operations, and any cheapening of the pig iron cost is reflected to a greater extent in the finished steel product.

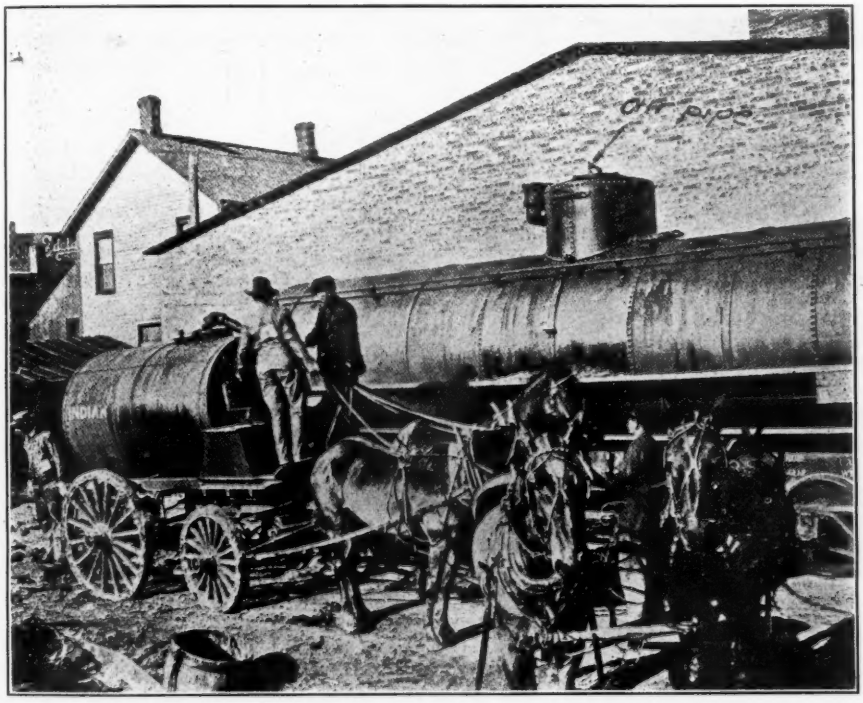
It is not necessary to offer any explanation of the diagram, which speaks for itself, except to call attention to the fact that the moisture scale is at the left hand and the temperature scale at the right hand.

LIFE ON VENUS

It is stated that Professor Pickering of Harvard University asserts that Venus, our nearest planet, is likely inhabited by huge monsters and gigantic lizards, such as roamed here in the primitive forests and lakes 300,000 years ago. It is not an easy matter to believe such statements came from a Harvard professor. These views belong to the past, which, of course, all astronomers know.

Venus is similar to the earth in size, density and gravity, but here the similarity stops. Venus, according to Professor Lowell, from observations at both the Flagstaff observatory and others, always presents the same side to the sun, and her day and year are the same length, she turning on her axis in the same time she revolves around the sun, which is 225 days. There is really no day and night there as on earth. It is always day on one and the same surface of Venus, and of course night on the opposite side. As Venus is only 67,200,000 miles from the sun, while the earth is 92,900,000 miles, she receives much more light and heat from our luminary than the earth gets. If our earth always presented the same face to the sun it would be but a short time

until all that surface would be wrapped in devouring flames and the other half of this globe in darkness and winter greater than the north pole ever knew. Now intensify this light and heat and let it continuously beat upon the same face of Venus for millions of years and the mind can but vaguely conceive the molten, and later baked, condition. The atmosphere driven from the burning half would rush to the dark, cold side to condense and then congeal into eternal ice. Between the hot and the cold line an equator would be formed, where the most terrific warfare of elements would be waged forever in such storms as have never swept our world. Life on Venus is unthinkable from our idea of what life must have to exist on the earth.



TRANSFERRING TAR BY COMPRESSED AIR

The half tone here reproduced from *Engineering-Contracting* practically explains itself. In many parts of the country the roads are being constructed of tar-macadam. The stone being first spread to the required depth, tar is then poured on to fill the interstices and to bind the material, which means that a large quantity of tar is used, and the selection of facilities for handling it becomes important. The tar is conveyed by railroad in tanks similar to those used for carrying oil, and from these it is drawn into horse-drawn trucks for the final operation. The material usually has been forced out of the tank car into the distributing by means of steam pressure applied to the top of the car. Steam pressure has not been found to be altogether satisfactory, on account of the water which condenses and remains in the car. When pressure can be furnished by compressed air, however, from, say, a portable compressor, the method is entirely satisfactory. In the case here shown the iron discharge or transfer pipe was 3½ in., the air pressure was 15 lbs., and 700 gallons were loaded in 5 minutes.

CARE OF PNEUMATIC TOOLS

The *Railway Age Gazette,* in a valuable series of articles on the Care and Selection of Machine Tools and Shop Equipment, prints the following from W. H. Snyder, Assistant General Foreman at the Stroudsburg shops of the N. Y., S. & W. R. R.

The use of pneumatic tools should receive the most careful attention of all workmen, and

especially of the foreman directly in charge An air hammer should never be put in service without first being well oiled with a good grade of suitable oil; if it continues in service it should be oiled every two hours without fail. Pneumatic tools are like a human being; without the proper nourishment and care they will very soon be a total wreck and useless for service. Never connect an air hose to an air hammer or motor without first blowing the hose out well. There is nothing that will ruin a pneumatic tool quicker than the dirt or grit that is liable to collect in an air hose. At our shop all pneumatic tools have to be delivered to the tool room every evening before the men go home; the hammers are put in a tank containing equal parts of signal oil and kerosene. This keeps them well oiled and prevents them from gumming up. In giving the tools out in the morning the hammers are drained out and given a good oiling with pneumatic tool oil. The motors are also well oiled before they are handed out.

The advice to clear the hose before using is especially important; of the complaints received by the makers, investigation shows a large proportion to be due to the stoppage of some one of the air ports by bits of rubber from the hose, which due caution would obviate.

Mr. Dyer, of the N., C. & St. L. shops at Nashville, Tenn., says:

Pneumatic tools are real labor savers. The foreman should instruct his men in the proper use and care of these tools; the main thing is to see that the air drills are properly lubricated. More air drills are ruined from the lack of oil than from any other cause. The air hammer should be more generally used in the erecting shop. Remember, the operator will more than double the output with it over the old way of using hammer and chisel. Instruct your apprentices how to use the air hammer.

An "Old Railroader," in this series of articles, says as follows concerning care of Air Motors and Hose:

The manner in which air motors and hammers are handled is as bad, if not worse. Instead of being placed on a rack or some other receptacle when not in use they are thrown on the ground and the motors are rarely shut off. As yards are made up of all kinds of filling it is easy to estimate how long a motor will last. Anything that is in the way or repair parts that are needed for cars are likely to be thrown on the motor or the hose. The damaging of hose by the careless handling of material often causes unnecessary expense and delay. To illustrate: A certain gang had considerable trouble with a particular motor for a couple of days and also with air hammers. They could not be made to work right and after the second trip to the shop it was decided to send a man to the yard to locate the trouble, as the tools worked properly at shop when tested. He found that the trouble was due to the hose and not to the motor; the inner lining was loose and the action of air in flowing to the motor closed it, with the result that no air could reach the motor.

The above cases serve to show that the fault can often be traced to the foremen and leading men, inasmuch as they fail to instruct the men and follow it up to see that the instructions are carried out. In case the men placed in charge do not know enough to instruct those in their charge blame must be placed on those higher up.

SINGING SANDS

The attention of the public has recently been directed to those curious freaks of nature, "singing sands." When a small quantity of this sand is clapped between the hands it is said to give forth a sound so shrill as actually to resemble a hoot. Put into a bag and violently shaken, the sand emits a noise strangely like the bark of a dog. The most notable of these sands are those of the Hawaiian island of Kauai. Similar sands also occur in the Colorado desert, where also are to be found those curious moving sands that continually travel hither and thither over the vast plain of clay. Their movements are induced by the winds, and when a strong breeze is blowing the particles of which they are composed give out an audible humming or singing. Under the microscope, these sands show an almost perfectly spherical form, so that they roll on each other at the slightest impulse, a circumstance that also accounts for the rapidity with which the sands travel over the desert. One theory advanced with respect to the "singing" of these sands is that it is due to an exceedingly thin film of gas that covers the grains. Gathered and removed from the desert, the sands lose their vocal properties.—*The Engineer, London.*

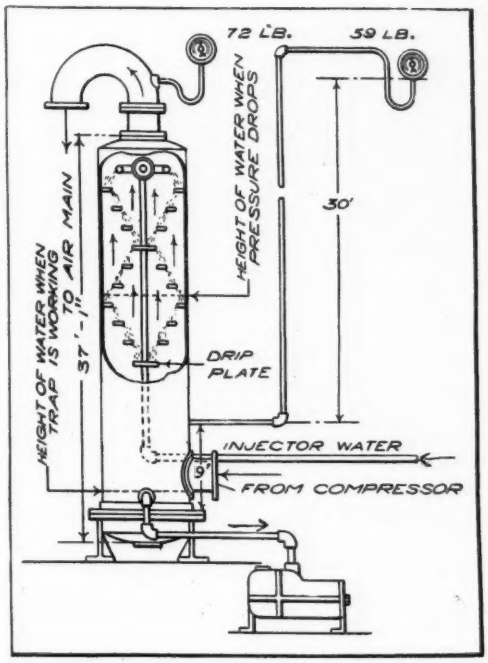
AFTERCOOLER EXPERIENCE

The cut herewith, reproduced from *Practical Engineer,* is a sketch furnished by a correspondent of that publication, who asks a question in connection with it. In this case a vertical air receiver, in itself of not abnormal type, has been converted into an efficient aftercooler without any material reduction of the receiver capacity. The receiver or cooler has within it two sets of drip pans arranged as shown, and water is injected at the top against the receiver pressure to successively overflow the several pans and thus to cool the air passing through, the water being automatically discharged at the bottom.

The temperature of the air in this case is reduced from 200 Fahr. to 70. The cost of providing and operating a pump or other means for injecting the water against the pressure would seem to be the principal objection to this arrangement, as with the familiar types of tabular aftercoolers the water is not under pressure and usually circulates by gravity alone. The actual contact of the air with the water is not objectionable, as the air would emerge in a saturated condition in any case. Provided that all the water released from the air by the cooling of it while at its highest pressure is actually removed from the air, instead of being carried along with it, there would be no trouble from water in the air farther along the line when its pressure became lower.

It seems in this case the trapping device for removing the water from the cooler sometimes failed to work and the water would accumulate in such quantity that its level would rise above the small pipe at the side leading up to the right hand pressure gage, and when that occurred the reading of that gage would be, as shown, considerably below the full air pressure as shown by the left hand gage.

This really is quite easily explained. Supposing the water to be left in the cooler above the gage pipe at a time when the compressor was stopped and the compressed air had been discharged, then upon starting the compressor and filling the cooler again with air at full pressure, water would be driven up the gage pipe, compressing the air in the pipe into the horizontal portion and the siphon, and if the water rose to the height of 30 feet it would have a back pressure of 13 pounds, or the difference between the reading of the two gages.



BOTH GAGES CORRECT.

MICE AND CANARIES AS MINE GAS TESTERS

The use of white mice on board submarine boats to give notice of escaping and dangerous gases—which they do by exhibiting uneasiness or by dying—has suggested the adoption of a like expedient in coal mines. When an explosion occurs in a coal mine the great danger to rescuers lies in the possibility or likelihood that there may be gas in the workings down below. There may be much gas or little gas; or there may be no gas worth mentioning. The rescuers, in any given case, are unable to tell; and men sent into the depths with helmets and oxygen apparatus have, of course, no means of ascertaining. The latest idea is for the helmet men to carry with them little cages containing two or three white mice. If the latter show no signs of distress the oxygen pioneers telephone back to that effect and then the members of the life-saving corps who are without protective apparatus are enabled to rush in fearlessly. "Come along! It's all right!" cries the helmet man through his portable telephone—and his mates follow. By this means much precious time, when minutes may mean lives, is saved. This plan has already been tried with success by a mining company

in Pennsylvania. One of its incidental advantages lies in the fact that the men do not wear helmets, and are thereby relieved of a burden of about forty pounds. Undoubtedly they can work much more effectively.

Caged canaries played a prominent part in the attempts made to reach the men suffocated by the explosion which occurred in a coal mine a few miles from Manchester, Eng., recently. Picked men from all pits in Lancashire were rushed to the Pretoria pit, and gang after gang attempted to penetrate the passages and galleries. At the head of each gang or relief team were six men equipped with breathing helmets whose duty was to repair the broken ventilation doors so as to restore the thorough ventilation of the pit, and to report the first indications of gas. Their lamps, of course, gave them an idea as to the condition of the air, but in addition they carried canaries in cages, as these birds show signs of distress at the first presence of gas. The Pretoria-pit disaster was the worst in England in many years, some 360 miners, among whom were many boys, being killed.

COST OF MODERN MINE EQUIPMENT

The following occurs in a commencement address at State College, Pa., by John H. Jones, President of the Pittsburgh-Buffalo Company, Pittsburgh, Pa.

In 1879, I remember, all that was necessary to open a coal mine was to make an investment of approximately $10,000 except in isolated cases where shaft mines were installed. I also remember that in the mine where I was working they produced about 160 tons of coal per day, and they did this by commencing work at 4.00 o'clock in the morning and working until 6.00 at night—fourteen hours a day!

To-day the conditions are entirely changed. A few years ago, when the largest mines in the world were equipped at a point on the Monongahela river and it was stated that these mines would produce 5,000 tons daily, many who claimed to know all about mining insisted that the company equipping these mines was making a great mistake. Instead of spending $10,000 they spent more than one million dollars before they dumped a ton of coal. To-day these same operators and miners point to that mine with pride and say—"There is the largest mine in the world." These mines have produced one thousand tons of coal in an hour—certainly this is a great change—one thousand tons per hour, 166 tons in ten minutes; more coal in ten minutes than the average mine produced in fourteen hours thirty years ago! This is wonderful progress, and it has been made possible only by thought, knowledge, and the application of the principles that we have here set forth.

To open and operate modern mines to-day requires the best engineering talent, experienced superintendents, and mine foremen whom the State will certify as efficient and capable of taking care of the mines. In some of the large mines as many superintendents, mine foremen, fire bosses and other foremen are employed to-day as were employed in every department of the mine thirty years ago.

Thirty years ago, as I said, it cost $10,000 to equip and open an average mine, and to-day it costs a million dollars or more to equip and develop a modern mine; therefore, if you are the right man, do you think that a man who has millions invested will hesitate to employ you at a higher salary than is received by the Governor of the Commonwealth? I answer "No." He would get a bargain at that price.

I know of several miners who, ten years ago, began studying to secure mine foremen's certificates . These men have made good, and are to-day receiving salaries ranging from $3,000 to $20,000 per year; many others are in business for themselves.

HIGH PRESSURE GAS FOR SHOP USE

High Pressure gas for manufacturing and general power purposes, also for street lighting, is now being delivered in Birmingham, England. The normal gas pressure there has been about ⅛ lb. per sq. in., measured as usual in inches of water; the "high" pressure is about 8 lb., gage. The first trial of it has been made at an aluminum casting works, where it melted about 100lbs. of aluminum in one hour, which should not seem remarkable.

The furnaces are of the simplest construction, there being an enclosure of fire-clay about 3½ in. thick. No special burner is required, though a careful adjustment of the air aperture in the furnace is necessary. It was calculated that the melting of 112 lbs. of aluminum cost 32 cents, which was lower than the cost of coke while there was an entire absence of oxidation.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

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[In our March issue, page 5978, second column, the first line of type below the cut belongs at the top of the column.]

FREEZING-UP OF COMPRESSED AIR PIPE LINES

In northern countries great inconvenience is caused by the freezing of compressed-air pipe lines. The difficulty has been eliminated to some extent at permanent, well regulated properties by burying the pipe. Even in these installations trouble is often experienced in the smaller lines to blacksmith shop or exploratory shafts, which may be at some distance. A method whereby this difficulty could be eliminated for all time would be acceptable and has been the cause of much study, as nothing disorganizes a force of men so much as the gradual or sudden loss of air supply.

In the latitudes where weather from zero to 40 deg. below is occasionally experienced, the pipes freeze from the circumference, gradually diminishing the pipe area until the passage is entirely stopped. As a preventive of this, the introduction of salt or sal-ammoniac has been found very effective up to the moment of entire blocking of the pipe. At a number of properties a barrel of salt is kept in the engine room and at regular periods, usually at the beginning and middle of each shift, several pounds are introduced into the pipe line just beyond the air receiver. The pressure is then increased by the air compressor and the salt blown through the pipe, flushing out the ice. The quantity of salt necessary is, of course, dependent upon the size of the plant. There is a record of one line transmitting approximately 1000 cu. ft. of free air per min. for 1700 ft. where two barrels of salt were used in the course of the five winter months, and completely did away with all freezing troubles.

In pipe lines where sags exist, no trouble is encountered by freezing in the dips, as the salt collects as brine, preventing freezing. For quick relief from a partly frozen line, the pipe is sometimes used as a part of an electrical circuit temporarily until the pipe is warmed sufficiently to blow the ice out.—*Stacy H. Hill in Eng. and Min. Journal.*

Perhaps it is nowhere more true than in

compressed air practice that prevention is better than cure. Get the water out of the air before it commences its travel in the pipes, and there will be no freezing and choking of the pipes afterwards. There should be an aftercooler and then a separator, if the two functions are not combined as they should be, as near the compressor as possible, when the air is at its highest pressure. If the air is then brought to the lowest possible temperature it will give up its surplus of water, or, what is not quite the same thing, will be in condition to do so. The lowest temperature possible with aftercoolers of the usual types must of course be a little above the freezing point, but by the use of brine this might be carried lower. When the air so dried is conveyed through pipes much colder there will still be some deposition of moisture and consequent accumulations of ice coatings in the pipes, but the trouble will be minimized. Beyond the aftercooler in extreme cold weather the further drying of the air is a question of expense. There might be alternate pipe lines of sufficient length to permit of the thawing and draining of one while the other was in use, but this few would resort to.

A suggestion quite pertinent in this connection comes to us from the *Natural Gas Journal,* where a correspondent writes of a similar trouble and his method of treating it in the transmission of natural gas. He writes:

"As to the use of cooling tanks at the wells to reduce the temperature of the gas before it goes into the lines, now that cold weather is with us again, it might not be inopportune to say that I have found it effective to accomplish this purpose by using an extra large sized pipe from 100 to 1,000 ft. long next the well, so that a considerable amount of hoar frost can accumulate inside of the pipe, before its internal orifice becomes so much reduced as to cause a noticeable difficulty. At the end of this large pipe, I put a water catch or tank. Then, whenever a melting day comes, this hoar frost melts and is carried forward by the flow of gas into the water catch, from which it can be let off in the usual manner. The advantage of this over using tanks alone, is that there is a larger cooling surface; the gas is more thoroughly chilled and less likely to cause trouble on the other side of the water catch or tank."

TURBOCOMPRESSOR EFFICIENCIES

Editor Compressed Air Magazine.

The article on the Turbocompressor appearing on page 5940 of the February issue of COMPRESSED AIR contains some statements which I cannot allow to pass without a few remarks.

The first statement is that "it is claimed that even at pressures as high as 150 pounds per square inch, the new type of turbocompressor is at the very least equal in thermal and mechanical efficiency to the very best kind of reciprocating air compressor." The objection to this statement is found in a direct contradiction on page 5942 where the article says that "the high efficiency already obtained (78 per cent.) as referred to adiabatic compression, places these turbo blowers very favorably in comparison with the best reciprocating blowing engines." This must, of course, include mechanical efficiency. As first class manufacturers of modern reciprocating air compressors are guaranteeing from 85 to 88 per cent. for this item, in large machines comparable in size to the turbo units, the statements above given seem exaggerated. With the turbo machine it will appear also that the efficiency of compression decreases with increase of pressure; whereas, with consistent design this efficiency increases with the ratio of compression in the reciprocating machine.

Going back to page 5940, the following remark is given: "They run practically without noise at all loads". I, myself, have never been present when one of these machines was operating, but from first-hand reports I understand that they make considerable noise not unlike a sharp whistling shriek. This may not be any worse than the pounding of poppet valves of the reciprocating machine, but at any rate the turbo machine scarcely can be called noiseless.

The next statement is that they require a minimum of power to drive. The objection to this has already been given. The statement immediately following the above; namely, that they are easily governed through a wide range of variation of speed, without materially affecting the economy, may be a good point as opposed to the reciprocating machine, although the curve in Fig. 5 seems to show a falling-off in efficiency. How this compares with vari-

able speed control of the reciprocating steam machine, or with the clearance controller of the Ingersoll make, or the automatic air cut-off of Nordberg for constant speed, would surely be of interest.

On page 5941 the article includes a paragraph on the greater efficiency of cooling the air in the turbo machine. This of course is true and the maker of the reciprocating machine scarcely hopes to effect economy through jacket cooling. Judging from this you can see that the much greater efficiency of the reciprocating air cylinder points to the fact that there must be some other very serious losses in the turbo machine.

Of course, if the turbo machine is driven by a steam turbine the economy of the steam end may be much greater than the steam end of the reciprocating machine. Some figures which I lately received from a large installation of large turbo compressors, however, do not seem to point to anything unusual in this line. This advantage with the steam machine would fail entirely with an electric driven unit and you know that the call for this latter style of machine is increasing every day with the additional facilities for long distance electric transmission.

S. B. REDFIELD,
Associate Editor American Machinist.

[The article on Turbocompressors was reproduced from an authoritative English source, which we regret that we are not now able to identify with certainty. With regard to the principal contention of our correspondent, that as to the efficiency of the Turbocompressor, which is the only one which we have space to consider, it is proper to remind Mr. Redfield that there are efficiencies—and efficiencies. In Richard's "Compressed Air," published fifteen years ago, there were (pages 94-97) enumerated four consecutive discounts, if we may call them so, to be deducted from the theoretical computation to obtain the ultimate efficiency. A fifth discount on account of leakage of piston and valves was not thought of. The conclusion reached was: "It is safe to say that the ultimate efficiency never goes as high as 80 per cent., while it often goes below 60 per cent. If any compressor builder feels aggrieved over this statement, a fine opportunity is opened for a demonstration of a higher efficiency." And up to date no compressor builder has been heard from, at least by the writer. In Peele's "Compressed Air Plant," second edition, published last year, there are reports of various tests of steam driven compressors, the efficiency percentages of some of which are given as follows: Page 171, 78.1; page 180, 60.8; page 184, 67; same page, 59. The last item was volumetric efficiency alone. On page 186 there is a friction loss of 39 per cent. between the steam and the air cylinders, or a power efficiency of 61 per cent., and so it goes when efficiencies are talked about.—Ed. C. A. M.]

COMPRESSED AIR TRANSMISSION FORMULAS

Editor Compressed Air Magazine.

Referring to the formula and tables for friction of air in pipes presented on page 5950 of your Feb. issue, [The Rix-Johnson formula, used in article by Frank Richards. Ed. C. A. M.] I have compared the results given by this formula with those obtained by the formula in Harris's "Compressed Air," and I find they check each other to a surprising degree, within the limits over which the formulas are intended to apply. However, neither will give reasonable results for very high velocities and low pressures. But we should note that the authors exclude such cases by the conditions or assumptions under which the formulas are developed. In comparing the labor of computation, the Harris formula has much the advantage, since it is adapted to straight logarithmic computations. Moreover, the Harris table or diagrams, either of them, covers the whole field of practice in a most concise and simple form, rendering the labor of computation almost nil.

OBSERVER.

[It is gratifying to be assured how completely these two formulas corroborate and endorse each other. Beyond that it may be said that the two formulas will suit two distinct classes who have occasion to use them. It is perhaps to be regretted that there are two classes, but we may expect them to always exist. The Rix-Johnson formula calls for simple arithmetic and nothing outside of it. The Harris formula must have a table of logarithms at hand and some familiarity with, and reliability in, the use of them. Ed. C. A. M.]

"THE SUBWAY EAR"

Editor Engineering News.

In a recent issue of the *Saturday Evening Post,* which does not knowingly use the incorrect or the misleading for holding the interest of its readers, there appeared a little article with the above title, in which it was stated that those who habitually ride in the subway are having their hearing impaired by the air pressure to which they are subject. "To provide the requisite ventilation", it was said, "air is continually forced into the underground tunnel. Consequently the air in the subway is at a pressure considerably greater than outside. When a person descends into the tube his eardrums are bulged inward; when he leaves the tunnel the sudden removal of pressure causes them to bulge outward. This when often repeated, is liable to set up an irritation, which in turn may bring about catarrh, etc., etc."

Now it may be true that riding in the subway does have a deleterious effect upon the hearing, but not on account of the increase of air pressure, for there is no such increase. The other day I put my little pocket aneroid in my pocket and entered the Subway at 125th street and Lenox avenue, riding continuously to Bowling Green, say about eight miles. Going down from the sidewalk to the station platform there was an increase of pressure represented by .04 inch of mercury, or, say, .02 lb. per square inch. In all the trip there was no increase of pressure above this. In fact the pressure began to fall, but the fall at the greatest was only .10 inch of mercury, or, say, .05 lb. The somewhat lower pressure, within this slight range, continued through most of the trip, the final reading on the Bowling Green platform being identical with that at 125th street.

It may be contrary to the popular impression, but there is no artificial forcing of air into the subway. The fans which were tried for the purpose did not produce satisfactory results and, as narrated by Dr. Soper in his excellent Boston paper upon subway conditions, their use was discontinued, relief having been ultimately found by making large openings between the tunnel and the outer air, and through these, as Dr. Soper says, the tunnel "breathes" both inwardly and outwardly, and the tunnel pressure is the same as that outside except for the slight difference due to the difference of altitude.

In riding up or down in the elevator, between the sidewalk and my room on the 14th story where these lines are written, the barometer shows a change of pressure just double that observed in the eight mile subway trip.

FRANK RICHARDS.

NEW BOOKS

Applied Thermodynamics for Engineers, by William D. Ennis, M. E., Professor of Mechanical Engineering in the Polytechnic Institute of Brooklyn. New York: D. Van Nostrand Company. 446 pages, 6¼x9¼ inches, 316 illustrations. Price, $4.50 net.

Although, as the author says, the title of the book is a broad one, the spread of the book itself is commensurate. The theories of thermodynamics are clearly presented, and the practical portion covers the entire field of power development and application, beginning with compressed air, then treating successively of hot air engines, gas power, the steam engine, steam turbines, the steam power plant, distillation, mechanical refrigeration. The first and the last of these topics, in which we are most interested, are treated so completely as, in a way, to guarantee all the rest. Each chapter is supplemented by an extensive and excellent set of problems to be worked out.

Motion Study, a method for increasing the efficiency of the workman, by Frank B. Gilbreth. Introduction by Robert Thurston Kent. New York, D. Van Nostrand Company. 140 pages, 5¼x7¾ inches, 44 illustrations. Price, $2.00 net.

This book at a casual glance might be called a study of the laying of a brick, but it really does make an astonishing presentation of the possibilities of labor saving by systematic study of the movements involved in specific operations and by the arranging of them in their proper sequence.

A. S. M E. PITTSBURGH MEETING

The spring meeting of the American Society of Mechanical Engineers will be held in Pittsburgh, Pa., May 30 to June 2, inclusive. The society now has in the Pittsburgh district a membership of about 160, and it has not met there since 1884.

An executive committee consisting of E. M.

Herr, chairman, George Mesta, J. M. Tate, Jr., Chester B. Albree, D. F. Crawford, Morris Knowles and Elmer K. Hiles, secretary, will have charge. It is expected that from 300 to 400 members and ladies will be in attendance. There will be professional sessions when papers will be read and discussed. There will also be inspection trips through the leading local industrial establishments, besides automobile trips through the parks, a visit to Carnegie Institute, Memorial Hall, etc.

AN INCIDENTAL TAYLOR AIR COMPRESSOR

E. H. Sellards, in a recent issue of *Science,* describes a "spouting well," which is practically a Taylor air compressor although unintentionally produced. The Taylor compressor has been frequently described in our pages, the last occasion being the large construction at Cobalt, Ontario, June, 1910. The following is Mr. Sellard's account:

In parts of Central Florida bored wells are somewhat extensively used for drainage purposes. The wells are drilled through the superficial material and as a rule enter the Vicksburg limestone of Oligocene age, although other porous limestones may serve the same purpose. Many of the wells terminate in cavities in the limestone, while others reach layers of shell or other porous material. Surface water entering the wells is carried into the limestone formation. In some localities in the central part of the State these wells have been found efficient in carrying off surface water and in draining small marsh areas.

One of these drainage wells near Orlando, in Orange County recently developed the unusual phenomenon of spouting. The well was drilled, in 1907, near the edge of a small lake. It is 12 inches in diameter, has a total depth of 260 feet, is cased 60 feet, and terminates in a cavity in the limestone. The level of permanent underground water at this locality is 33 feet from the surface. The well is intended, by carrying off the surplus water, to prevent the lake from rising above a given level, since to do so would flood the farming land.

When first seen by the writer the water of the lake stood a few inches above the level of the top of the pipe, and the well was receiving water at much less than its full capacity. At intervals of a few minutes the well would reverse itself and spout, throwing a column of water into the air. The spouting comes on gradually. First, the well ceases to receive water and begins bubbling; The column of water follows, rising with considerable force to a height of 20 feet or more above the surface, the spout occurring with tolerable regularity at intervals of four minutes. The manager of the farm states, however, that the interval between spouts varies from 2 to 15 minutes.

Although drilled 3 years ago and receiving water more or less continuously during that time, the phenomenon of spouting developed for the first time in September, 1910. The well continued spouting without interruption for a little more than a week and until shut off by the owner.

At this stage of the lake the well is receiving water at less than its full carrying capacity and as the water enters the vertical pipe it forms a suction, carrying a large amount of air into the well, which doubtless collects in a chamber or cavity along the side or at the bottom of the well. As the well continues receiving water the air accumulates under pressure in this chamber until ultimately the pressure under which the air is confined is sufficient to overcome the weight of the overlying water plus the inertia of movement and hence rushes out with considerable force, carrying the column of water with it. The fact that the well when first drilled did not spout and afterwards began spouting indicates that the essential conditions were subsequently developed either by caving or by other changes in the underground conditions.

TO SAVE BOTH SIDES OF A SHEET OF PAPER

Those who are in the habit of collecting, filing and indexing, engineering and other data are often troubled by the fact that the matter to be preserved runs over to the other side of the same sheet, or different and unrelative articles both of value are upon opposite sides of the same paper. For the relief of such the following description of the process of splitting paper has been prepared:

Procure two pieces of cotton cloth slightly larger than the sheet of paper which it is desired to split. Cover the paper with a thin coating of flour paste; dampen one of the pieces of cloth and place it over the pasted side of the paper; smooth out carefully, taking particular pains to see that there are no

air bubbles under the cloth. Now paste the other side of the paper and cover with the second piece of cloth in exactly the same way as with the first piece. Allow the cloth and paper to become thoroughly dry, and then pull the two pieces of cloth apart gently. The paper will separate in the center, leaving a face attached to each piece of cloth. To remove the paper, soak the cloth in water and then gently detach. With a little practice on waste paper, one can soon become quite proficient in splitting sheets. The method described works admirably on fairly heavy paper, and it is suggested that those desiring to try it, work on a heavy grade first. With thin paper, considerable more time and skill is required.

NOTES

Cast iron or malleable iron that has been sand-blasted instead of pickled for cleaning the surface, gives, according to the *Brass World,* much better results in electroplating, as there is less liability to "spot out." Many platers have, therefore, abandoned the pickling of castings.

One ton of refrigeration is the amount of heat absorbed by the melting of 2,000 pounds of ice at 32 degrees F. into 2,000 pounds of water at 32 degrees F., or the amount of heat that must be extracted from 2,000 pounds of water at 32 degrees F. to reduce it to 2,000 pounds of ice at 32 degrees F., or $2{,}000 \times 142 = 284{,}000$ B. T. U.

Compressed-air sewage ejectors were put in a few years ago in Guildford, England, to raise sewage from low-lying areas and permit it to discharge into the basins at the sewage-treatment works. There are eight of these ejectors in use with capacities ranging from 50 to 1200 gal. per min. The compressed air for operating them is furnished by a power station situated adjacent to the town refuse-destructor. The waste heat from this destructor generates sufficient steam to drive the air-compressors which raise the sewage.

What is said to be the largest rubber suction hose ever made was made for a Philadelphia dredging firm, to be used in a deep water operation. The outside diameter of this hose is 33 inches, while inside it measures 29. The 1,290-pound spiral spring which comprises the foundation of the hose was rolled cold from a rod 1 inch in diameter. The rubber and fabric entering into its construction weighed 3,215 pounds. The rubber and duck were applied in alternate layers with coatings of gum, after which the entire piece was placed in a container and vulcanized with live steam.

It is reported that an aerological observatory will be erected on the Iselberg (altitude 916 meters) by special direction of the Duke of Saxe-Coburg-Gotha. The task of installing this station has been intrusted to the Lindenberg Observatory. It is also expected that an aerological station will shortly be opened on the Feldberg, in the Taunus Mountains, Prussia. These will be important additions to the German network of stations for upper air research. Germany is already far better provided for in this respect than any other country.

Syenite, cyanide and kyanite are pronounced nearly alike, but are names for very different things. Syenite is the not uncommon granite-like rock composed of orthoclase, feldspar and hornblende; in other words, a quartzless granite, named from Syene in Africa. Cyanide is well known in cyanide of potassium. Kyanite schist is a somewhat rare schistose rock, largely composed of the beautiful, pale blue mineral kyanite, which crystallizes in long, broad, flattened prisms of the triclinic system. The rock is more common in the eastern states. Cyanide and kyanite are both derived from the Greek kuaneos, meaning blue.

An interesting and apparently rational explanation of the thunder accompanying lightning is given in *Nature* by Herr H. L. Braun. According to this explanation the electricity discharged between two clouds or between a cloud and some object on the earth decomposes the small particles of water in the atmosphere into its constituents. The hydrogen and oxygen thus produced are mixed mechanically and form an explosixe mixture which is immediately ignited by the heat of the flash, and when exploding produces the characteristic rattling report of thunder.

Old man Dodder doubled the size of his dry kiln at the planing mill and found that the 5-horsepower fan was too small and would not deliver enough hot air. His nephew Bill was

back from college and tackled the job. He figured all over the side of the shed and told his uncle that to deliver twice the amount of air he would need a 125-horsepower engine to run the fan, as the rules showed one must cube the horsepower required to run the fan with the old kiln. The old man scratched his head and sent for Jim, the engineer, to help him out. Jim grinned and said that all they would need was another 5-horsepower fan, as the two would deliver double the amount of air.—*Power.*

The melting of metals in vacuum is the ideal method, because oxidation is prevented and gases present in the metal are expelled from it. While it has long been known that the method of melting metals in a vacuum gave superior results in the final product, the method has been limited to very small quantities of metal, due to the difficulty of carrying it out in practice. Metals which ordinarily are considered as brittle substances, and incapable of being rolled or drawn, can be produced, by melting them in vacuum, in a malleable or ductile condition. Examples of such metals are tungsten and tantalum, which in this way can be made in the form of wire, and are used to a great extent in the newly bought incandescent electric metallic filament lamps.

The *Engineering Review* mentions a case of a large gas engine plant which was some time ago exported from Great Britain to a British colony and erected at the location several thousand feet above sea level. The engines did not give the power expected from them and several reasons were advanced to account for this deficiency. It was finally concluded that the loss of power was due to the altitude of the power station. Upon investigation of the theoretical and practical considerations involved it was found that there is a loss of about one per cent. of the indicated horsepower for each 1000 feet increase in elevation. The effect of an increase in elevation on an engine with a low ratio of compression is slightly less than on an engine with a high degree of compression.

In the discussion of a paper on mining locomotives before the South African Institute of Engineers Mr. Kenneth Austin, author of the paper, says that the costs of operating large European mine haulage systems, which costs include allowance of 10 per cent. for depreciation, are as follows: (1) electrical overhead wires operating locomotive, 1 ct. per ton mile; (2) compressed air locomotive, 2.4 cts. per ton mile; (3) benzol locomotive, 3.2 cts. per ton mile; (4) electrical accumulator locomotives, 3.6 cts. per ton mile. The figures show the electrical overhead wire system to be the cheapest but that it has its disadvantages is apparent, for at Kimberly, the overhead wire system was tried and abandoned in favor of mechanical rope haulage. The electric locomotives gave satisfaction but the total working costs were lower for the mechanical rope haulage on account of the fact that white labor was necessary with the locomotives. The cost of installation of the electric system at Kimberly was about five times as great as for the rope haulage, which was also a determining factor.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

FEBRUARY 7.

983,284. STARTING DEVICE FOR EXPLOSIVE-ENGINES. FREDERIC N. HOWARD, Harris, R. I.

2. A starting device for explosion engines comprising a distributing chamber arranged to contain pressure sufficient to start the engine, valves controlling the passage of the pressure from said chamber to the engine cylinders, means whereby said valves may be unseated by the pressure in said chamber, a magnet for controlling the operation of each valve, and selective means for operating said magnets.

983,293. STREET - DUST - REMOVING MACHINE. ARNOLD KUNDIG-HONEGGER, Zurich, Switzerland.

983,363. PNEUMATIC MINING - MACHINE. MARTIN HARDSOCG, Ottumwa, Iowa.

983,374. PNEUMATIC MUSICAL INSTRUMENT. EUGENE DE KLEIST, North Tonawanda, N. Y.

983,426. ELEVATOR-OPERATING MECHANISM. EDWIN CARLSON, Minneapolis, Minn.

3. The combination with an elevator car and means for raising and lowering the same, of a counter-poising device for said car, comprising a cylinder and a piston, one of which is subject to movement of said car, and an air storage reservoir connected to said cylinder and affording a variable pressure on said piston.

983,574. VACUUM - SWEEPER. FRANK B. SHAFER, Northville, Mich.

983,605. COMPRESSOR. HENRY W. N. COLE, Brooklyn, N. Y.

983,610. BLEED-COCK FOR AIR-BRAKES. JOHN M. DOOLEY, Bloomington, Ill.

983,643. TRAIN-LINE-VENTING VALVE. FRANKLIN A. PIERCE, Wheeling, W. Va.

983,729. FLUID-ACTUATED AIR - PUMP. SAMUEL C. LAIDLEY, Chicago, Ill.

983,793. PNEUMATIC - DESPATCH - TUBE SYSTEM. FRANKLIN H. WOLEVER, Chicago, Ill.

983,806. OXYGEN - GENERATOR. RICHARD CLINTON BRADLEY, Shreveport, La.

983,808. METHOD OF SINKING CONCRETE COLUMNS, PIERS, AND THE LIKE. CHRISTIAN B. CHRISTIANSEN, New York, N. Y.

983,813. AIR-COMPRESSING BLOWER. PETER J. FANNING, Providence, R. I.

983,834. DEHYRATION OF CAUSTIC ALKALI. PAUL ERWIN OBERREIT, Ludwigshafen-on-the-Rhine, and FRIEDRICH MORITZ JAHRMARKT, Mannheim, Germany.

1. The process of obtaining caustic alkali from solutions thereof which consists in concentrating the caustic alkali solution until it has reach the point at which it would act upon the material of the containing vessel, and then further concentrating *in vacuo* at a temperature sufficiently low to prevent action of the material of the vacuum drier but sufficiently high to drive off substantially all of the water.

983,837. LEAK-ALARM FOR PNEUMATIC TIRES. EMIL J. F. QUIRIN, Tioga Center, N. Y.

983,865. SUCTION-PUMP. NAT H. FREEMAN, Boulder, Colo.

983,933. AUTOMATIC PRESSURE-GOVERNOR. WALTER J. RICHARDS, Milwaukee, Wis.

983,962. CAN-TESTER. CHARLES WERNER, San Francisco, Cal.

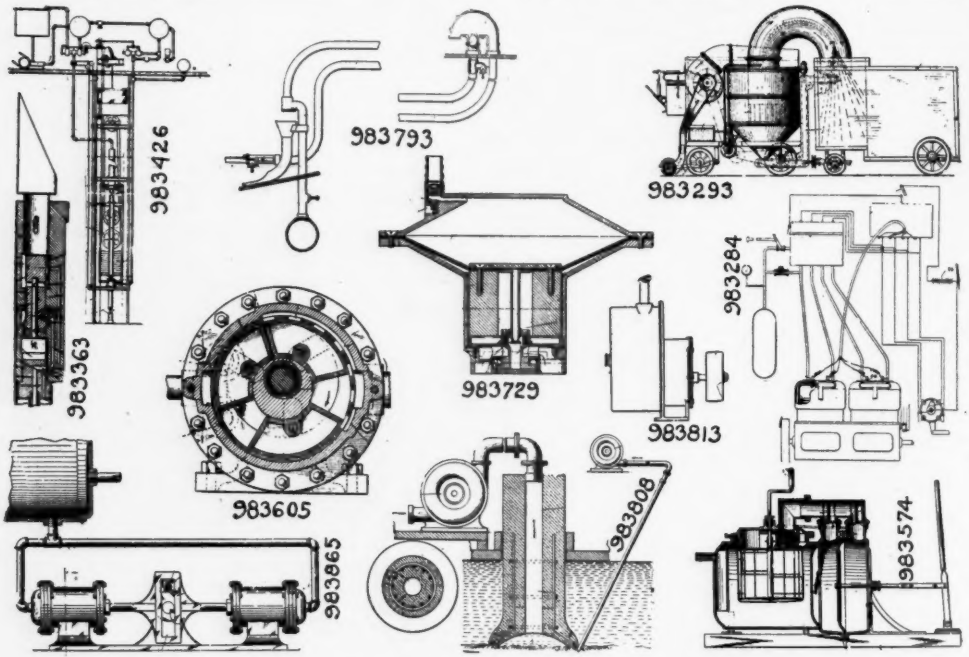
1. In a can tester, the combination with a clamp yoke having an arm furnished with a movable can clamp, and a hollow arm provided with a sealing head, a movable puncture device mounted on said hollow arm within said sealing head, and a pressure gage and source of compressed air connected with said hollow arm, substantially as specified.

983,971. PNEUMATIC CLEANING IMPLEMENT. ROY C. BAKER, Boston, Mass.

983,986. DRILL DUST-ARRESTER AND AIR-PURIFIER. WILLIAM E. DWYER, Leadville, Colo.

983,988. PNEUMATIC CLEANER. CHARLES B. FOSTER and WILMOT W. GLIDDEN, Oak Park, Ill.

984,030. GAS-LIQUEFYING APPARATUS FOR DEMONSTRATION PURPOSES. WILHELM PAUL SCHNEIDER, Hamburg, Germany.



PNEUMATIC PATENTS FEBRUARY 7.

4. A suction pump comprising a cylinder, a piston mounted to reciprocate therein, a conduit in communication with the cylinder, a reversible check valve located in the outer head of the cylinder, the inner head of the cylinder also having reversible check valves, whereby the said pump is adapted to cause either a suction or compression, the piston also having reversible check valves, and suitable means for operating the piston, for the purpose set forth.

FEBRUARY 14.

983,876. GOVERNOR FOR VALVES. FRANK L. CROSS, Detroit, Mich.

983,879. PNEUMATIC GOVERNOR. THOMAS DANQUARD, New York, N. Y.

983,882. DUST-ARRESTING AND AIR-PURIFYING DEVICE. WILLIAM E. DWYER, Leadville, Colo.

983,907. APPARATUS FOR GENERATING OZONE. CHRISTOPH KNIPS and EDUARD EY, Charlottenburg, Germany.

984,047. APPARATUS FOR DETERMINING DUST AND MOISTURE IN GASES. LESLIE A. TOUZALIN, Chicago, Ill.

984,072. AIR-GUN. WILLIAM J. BURROWS, Plymouth, Mich.

984,098. VACUUM CARPET-SWEEPER. CARL G. LUNDIN, New York, N. Y.

984,104. DIVING-SUIT ATTACHMENT. ENOS B. PETRIE, New York, N. Y.

1. The combination with a diving suit, of a relatively large hose connected at its upper end with a pop valve, and a smaller air supply pipe extending through the hose and into the suit.

984,112. PNEUMATIC TOOL. HENRY SCHUMACHER, Denver, Colo.

984,133. FLOATING DOCK. HANS GIESE, Berlin, Germany.

2. A floating or off-shore dock, comprising a bottom pontoon having a chamber into which water passes while lowering the dock and in which air is compressed by the entering water, a chamber to which water is admitted for sinking the dock, means for throttling the escape of

air therefrom to equalize the internal pressure with that of the outside, and means for forcing compressed air into said last-mentioned chamber to expel the water therefrom, to raise the dock while water is being at the same time expelled from the first-mentioned chamber by the air compressed therein.

984,144. AERATING-CHURN. THADDEUS S. LEESE, Avalon, Pa.

984,153. PNEUMATIC - PRESSURE GAGE. OLE OLSEN, Fruitvale, Cal.

984,171. ROCK-DRILL. DANIEL SHAW WAUGH, Denver, Colo.

984,187. APPARATUS FOR DISPENSING CLEANING FLUIDS. JOSEPH N. B. BOND, New York, N. Y.

984,220. AIR-CUSHION. JESSE G. HILTON, Prescott, Ark.

984,221. PRODUCTION OF GASES OF HIGH OXIDIZING EFFICIENCY. CHARLES HORNBOSTEL, New York, N. Y.

FEBRUARY 21.

984,549. PNEUMATIC STACKER. JAMES E. FOSTER, Clarksburg, Ontario, Canada.

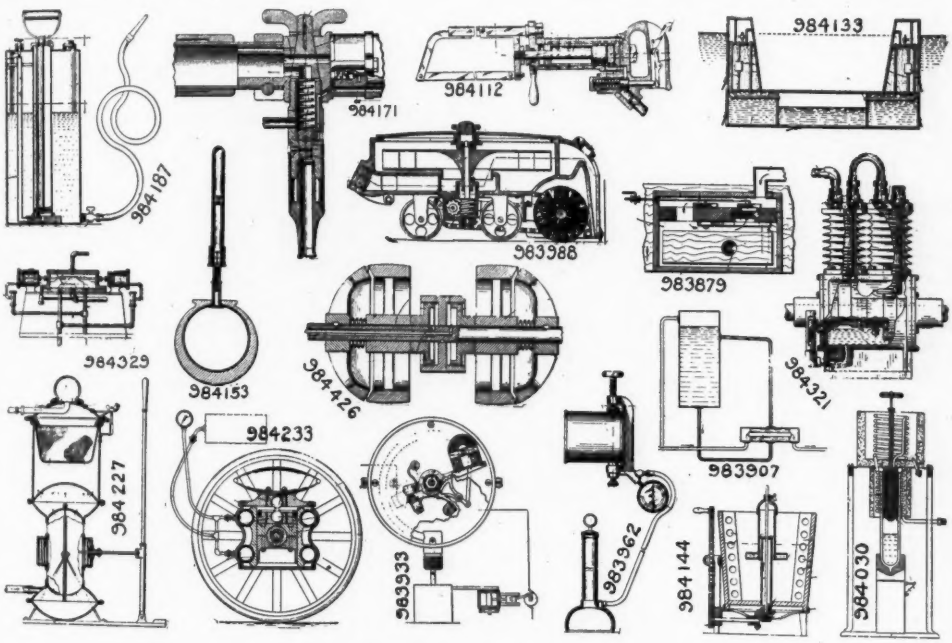
984,553. TEMPERATURE-CHANGING DEVICE FOR CARS. CASSIUS M. GAY, Los Angeles, Cal.

984,579. THERMOSTATIC MOTOR. FRITZ MARTI, Bas Obispo, Panama.

1. A device of the character described comprising a rotatably mounted container, a tube extended from said container, one end of said tube having communication with the interior of the container and adapted to contain mercury, whereby said device will be rotated by variations of density of air in the container.

984,585. SOLAR-HEAT MOTOR. EDWIN H. MCHENRY, New Haven, Conn.

2. The combination of a vaporizer, of a solar heat collector connected to said vaporizer, means for causing air to circulate through the collec-



PNEUMATIC PATENTS FEBRUARY 14.

984,227. SUCTION-PUMP FOR VACUUM-CLEANERS. JACOB C. LUDEN, Reading, Pa.

984,233. PNEUMATIC SUSPENSION FOR VEHICLES. GORDON A. MURPHY, Oakland, Cal.

984,321. COMPOUND AIR - COMPRESSOR. WILLIAM R. THOMPSON and ELMER E. CASE, South Norwalk, Conn.

984,329. PUMPING APPARATUS. FREDERICK C. WEBER, New York, N. Y.

1. Pumping apparatus comprising a chamber adapted to receive and discharge a liquid, means for alternately withdrawing air from the chamber and for supplying air thereto under pressure, a valve controlling the withdrawal and admission of air, and valve throwing means—actuated in one direction by air pressure from the said chamber and in the other direction by suction resulting from the withdrawal of air from the chamber—for throwing the valve in reverse directions.

984,426. PNEUMATICALLY - OPERATED CLUTCH. ARTHUR V. HANNIFIN, Chicago, Ill.

984,512. COMPRESSED-AIR DEVICE. ALFRED MCKNIGHT, Wilmington, Ohio.

tor and vaporizer, and means for supplying the air as it is heated with water vapor.

984,599. APPARATUS FOR STORING AND DISTRIBUTING WIND-POWER. STEPHANE PICHAULT, Valenciennes, France.

984,606. PORTABLE PNEUMATIC SHUTTLE-THREADING IMPLEMENT. ANGELO RICCI, Natick, R. I.

984,628. VACUUM-CLEANER. FRANKLIN C. WHEELER, Cleveland, Ohio.

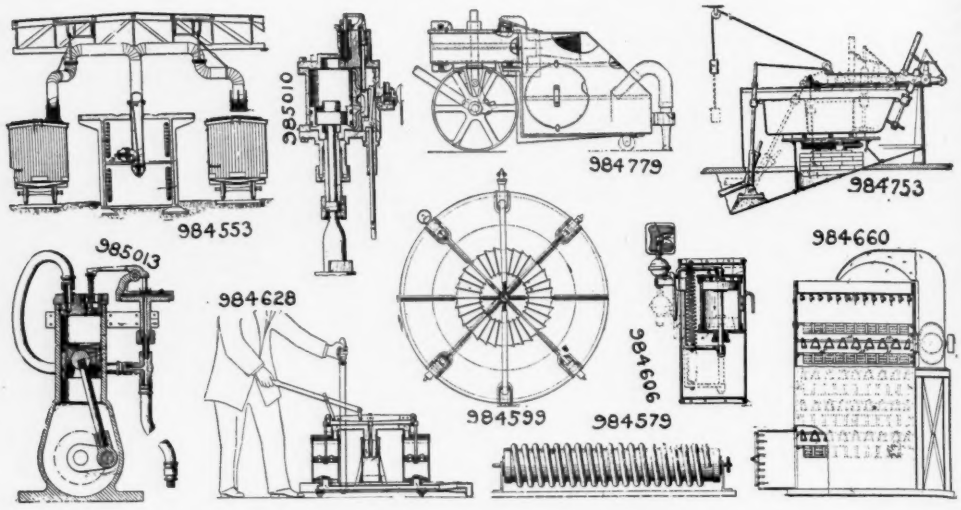
984,660. LIQUID - COOLING APPARATUS. FREDERICK W. HAAS, Pittsburg, Pa.

2. In a cooling apparatus, means for causing water to fall in a state of fine subdivision, means for passing through the same a current of rarefied air, and means for returning to the water supply any water carried with the air.

984,753. SAND-BLAST APPARATUS. CHARLES W. EBELING, Elm Grove, W. Va.

984,755. WINDMILL-GOVERNOR. WILLIAM A. FIFIELD, Minot, N. D.

984,779. PORTABLE AIR-SUCTION CLEANING APPARATUS. FREDERICK H. SANDER, Malden, Mass.



PNEUMATIC PATENTS FEBRUARY 21.

984,875. APPARATUS FOR LIQUEFYING GASES. ALBERT C. WOOD, Philadelphia, Pa.

984,925. PROCESS OF OXIDIZING NITROGEN OF AIR BY MEANS OF ELECTRIC DISCHARGES. KARL KAISER, Wilmersdorf, near Berlin, Germany.

985,010. FLUID - PRESSURE - OPERATED BOTTLE-CAPPING MACHINE. ROSS V. CRAGGS, Baltimore, Md.

985,013. AIR-PUMP. JOHN DESMOND, Chicago, Ill.

FEBRUARY 28.

985,131. WINDMILL. WILLIAM P. BENNETT, Woodstock, Ohio.

985,159. GAS-BLOW PIPE. NELSON GOODYEAR, New York, N. Y.

985,162. PNEUMATIC CUSHION FOR VEHICLES. LUCIEN R. GRUSS, Chico, Cal.

985,202. AIR-BRAKE ATTACHMENT. JOHN W. PAGETT and GEORGE F. PENINGTON, Chickasawba, Ark.

985,476. AIR-PUMP. EDWARD E. TRYON, West Hartford, Conn.

985,498. WINDMILL. ALFRED F. BARROW, New Haven, Ind.

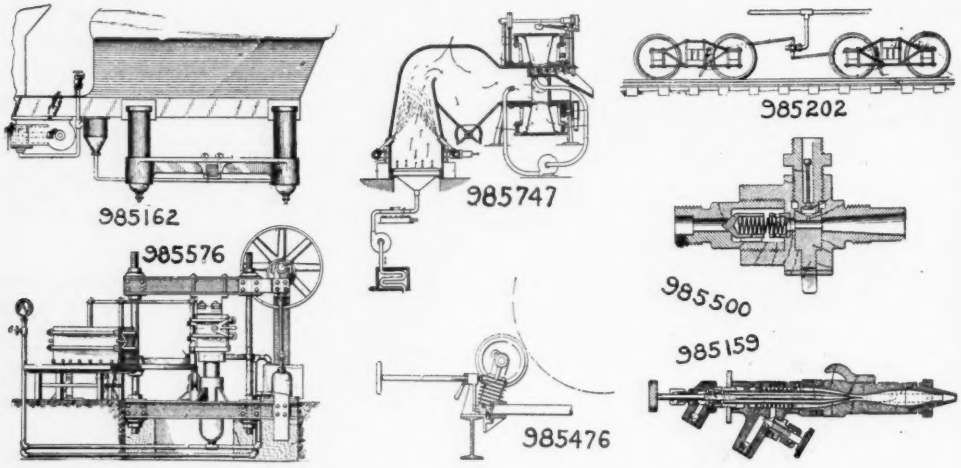
985,500. ATOMIZER. GEORGES BAUJARD, Paris, France.

985,576. MOLDING APPARATUS. WILLIS H. FISHER, Baltimore, Md.

985,694. PNEUMATIC CARPET-CLEANER. EDWIN E. OVERHOLT, Washington, D. C.

985,747. APPARATUS FOR DESICCATING LIQUIDS. IRVING S. MERRELL, Syracuse, N. Y.

4. In an apparatus for separating solids from liquid, a desicating chamber having an outlet, means for sprayng the liquid into the desiccating chamber, means for introducing an aeriform moisture absorbent into contact with the sprayed liquid and directing it toward the outlet, and a rotary dust collector having pockets movable successively into and out of communication with the outlet, said pockets being provided with at least one screened side to permit the exit of the moisture-laden air and retain the desiccated product.



PNEUMATIC PATENTS FEBRUARY 28.

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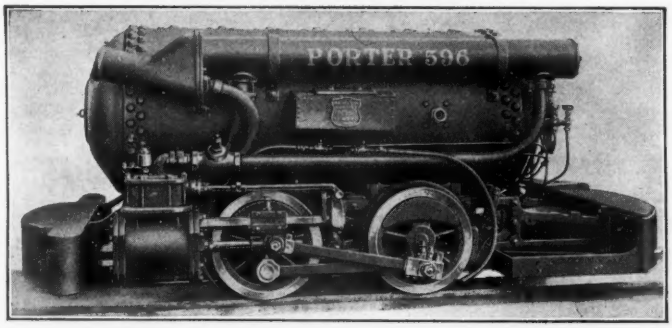

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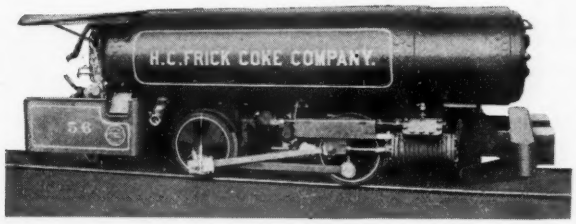

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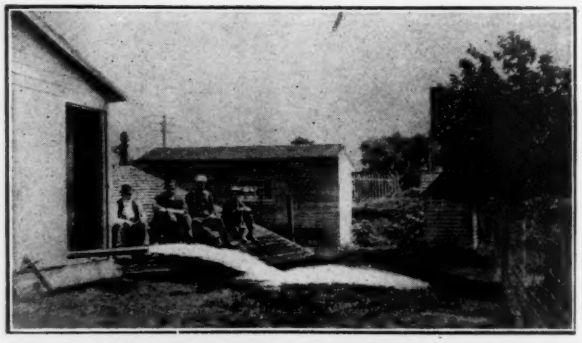

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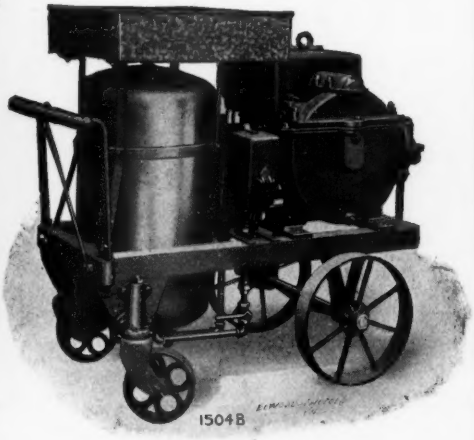

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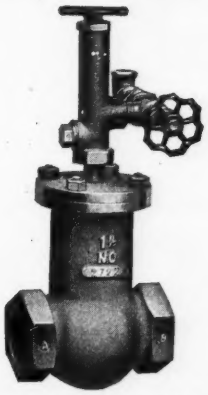

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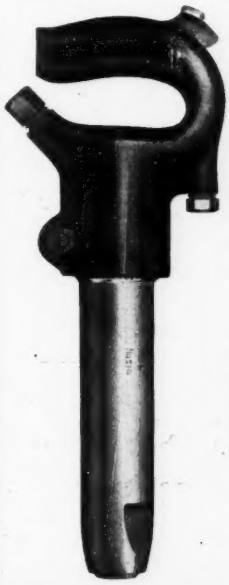

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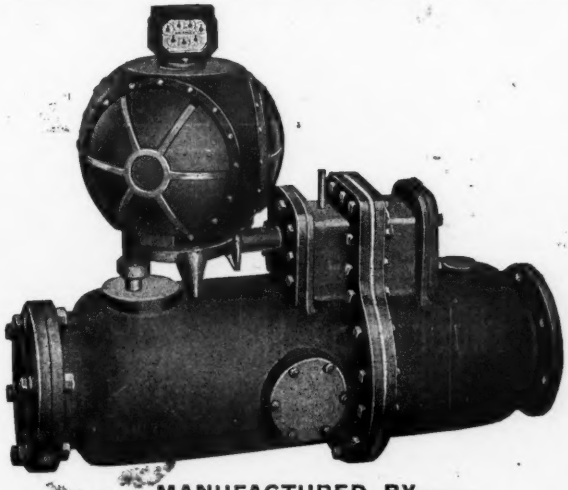

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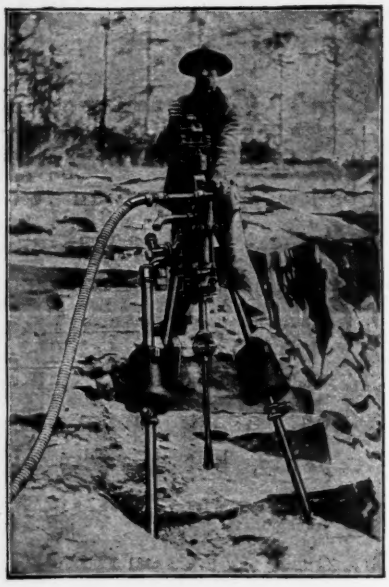

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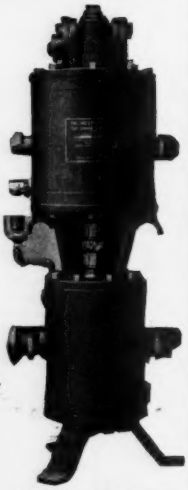

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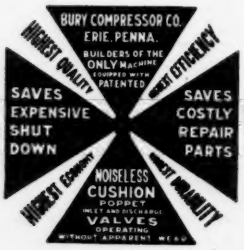
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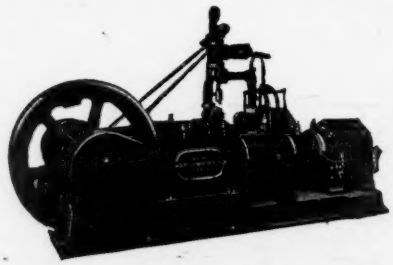

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